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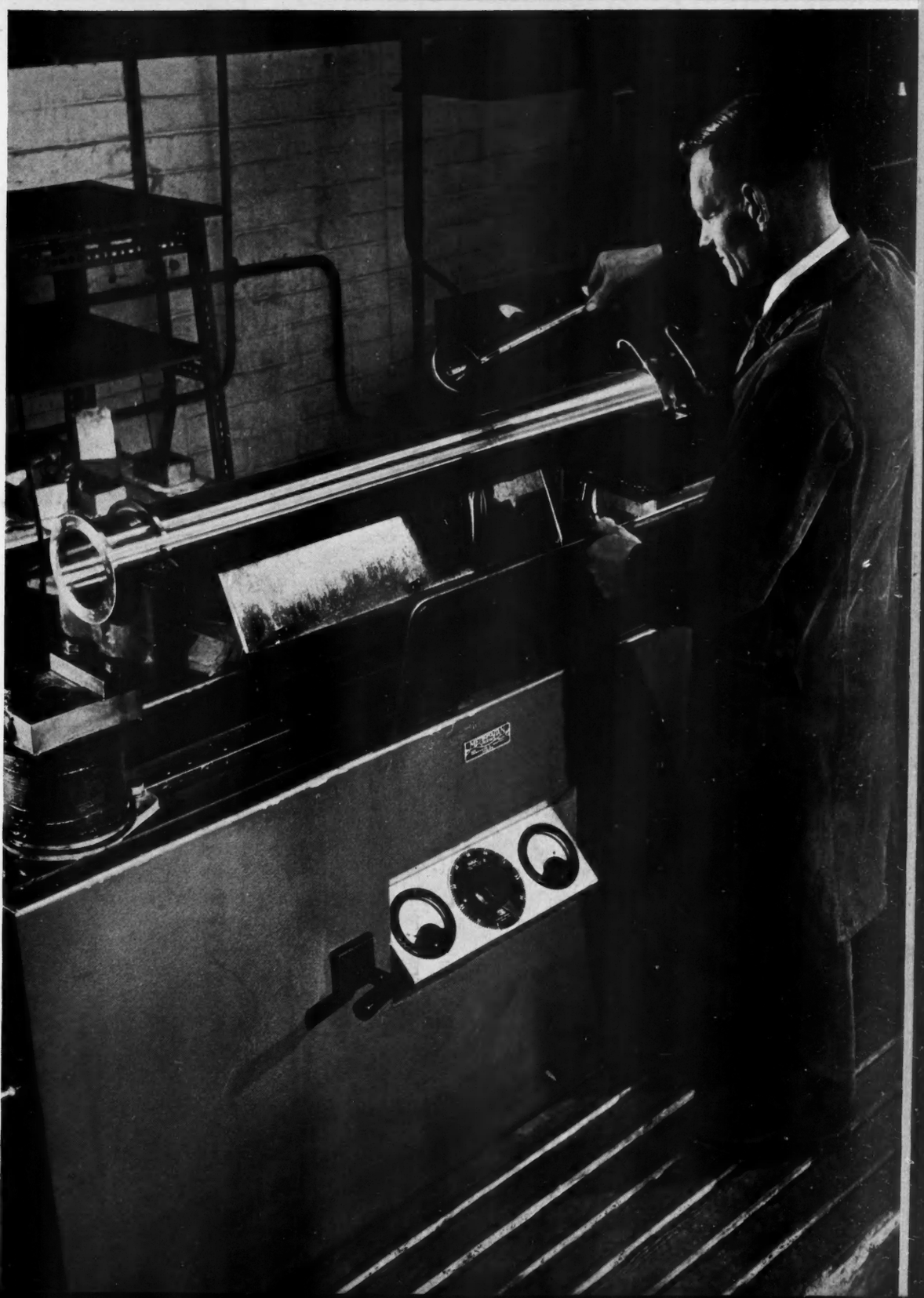

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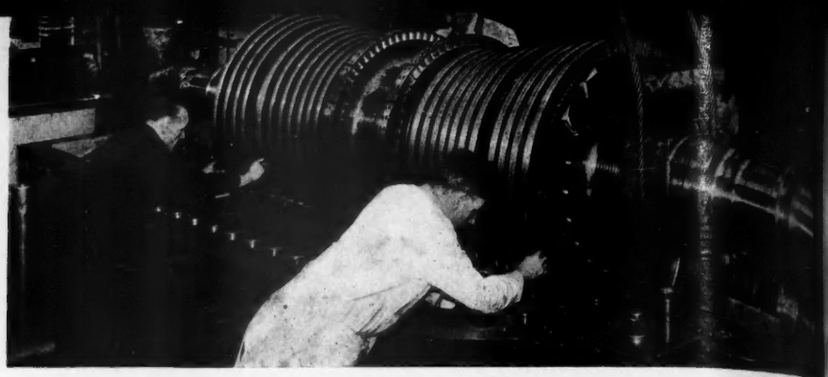

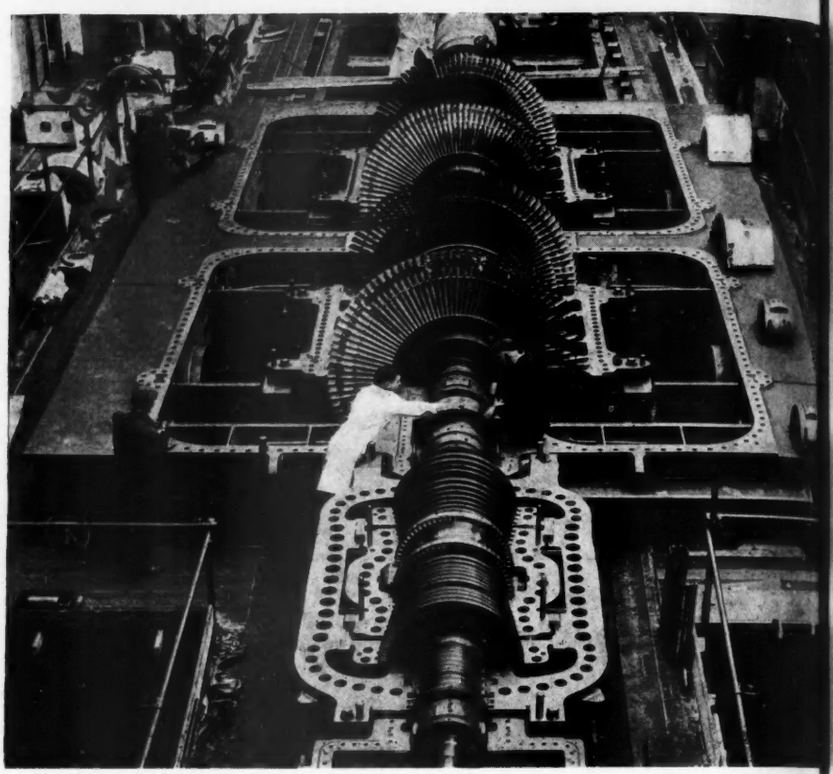

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Cover Picture

Checking alloy steel components for flaws at all stages of manufacture is now standard practice in many works. Magnetic crack detection is commonly used. It ensures that the minimum of work is carried out on faulty material. (*Nurnberg photograph for* ENGINEERING)

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Sept. 5	Machine tools and miscellaneous stores including	W.D. Storage Depot, South West Stores, Euxton Lane, Chorley, Lancs. (Sale at Cheetham Town Hall, Manchester, 8)	J. H. Norris & Son (Dept. J), 9, Albert Square, Manchester 2 (Tel. Blackfriars 8373)
	Centre, capstan, turret and boring lathes; horizontal miller; shaper; crankshaft, gear, tool and chucking grinders; radial and pillar drills; metal planer; punching and shearing machine; cross cutting and trenching machine; bandsaws; chain and chisel mortiser; wood turning lathe. Lister, Douglas & Reliance 1 and 2 ton auto trucks; industrial trailers; Coventry Climax fork lift trucks; trailer mounted air compressors; trailer mounted diesel and petrol generating sets; charging sets and switchboards; electric motors up to 120 h.p., M.T. spares; trolley jacks; electric hoists; sectional steel tank components; lead piping and sheet; alloy sheet; M.S. bar, tube and channel. Concrete mixer; pressure gauges; pump units; pipe cutters; steel scaffolding and clips; nuts, bolts, washers and screws. 6×30 binoculars; telescopes; anti-gas clothing; woollen and cotton textiles; rubber gloves; webbing, etc.		
Sept. 19	Vehicles, earth moving and lifting equipment and motor cycles	W.D. Storage Depot, Ruddington, Notts.	Walker, Walton & Hanson (Dept. J), Byard Lane, Bridlesmith Gate, Nottingham (Tel. 54272)
Sept. 21	Machine tools and miscellaneous stores	Technical Stores Depot, Old Dalby, Leics. (Sale at Melton Mowbray)	Shouler & Son (Dept. J), 1, Norman Street, Melton Mowbray, Leics. (Tel. 3081)
Sept. 26-27	Miscellaneous stores	Central Ordnance Depot, Bicester, Oxon.	Midland Marts Ltd. (Dept. J), Market Square, Bicester, Oxon. (Tel. 73)

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G 917

ENGINEERING Impact

of Computing by Telephone

It is always stimulating to discover that one of the technical services which is invariably taken for granted as a part of everyday life—the telephone—has not only caught up with later developments in its own field, but, in a satisfyingly logical way, has itself furthered progress.

This state of things has emerged again with the demonstration by Standard Telephones and Cables Limited of a data transmission and remote data processing system operating over telephone lines. Representing centralization in yet another form, this technique might well be seen to have far-reaching repercussions in engineering and commerce, for with it such operations as accounting, banking, stock control, invoicing or many technical calculations may be accomplished at one central computer receiving from a company's network of branches, and the required information re-transmitted—all this by telephone, as it were—at some 1,700 words a minute.

The public demonstration of this impressively rapid question-and-answer sequence was between STC's headquarters in Aldwych, in the centre of London, and their Harlow establishment 30 miles away—where a Stantec computer was fed with problems from London, answers being returned and printed out. A Harlow-Paris demonstration link is planned for September.

The possible amenities and economies of similarly centralized "brains" are advantages which have already been experienced by at least one major industrial company in the UK over the past year or so. They seem to point to another trend in our midst—computer efficiency for all, at an attainable cost.

The Broad Base of TUC Activity

The General Council's activities on behalf of the Trade Union Movement are not narrowly limited, either in scope or in character. So claim the general council of the Trades Union Congress in their introduction to the report that is to be submitted to the annual congress opening at Portsmouth on 4 September. And the evidence of their report supports the claim, for the TUC has submitted evidence to government committees and made representation direct to ministers on every conceivable subject. On a multitude of minor considerations the report is packed with small opinions. But it does not get down to the brass tacks of getting more production out of the national effort.

The agenda of the annual congress is the same. There are around 90 motions on the agenda—two demanding an extra public holiday every year on May 1—but only one under the heading of production and industrial development. This motion, from the Association of Scientific Workers, notes the limited amount of scientific research being undertaken in industries vital to the national economy, including the nationalized industries, and asks the congress to call on the government to increase substantially the funds allocated for research in the nationalized industries, if necessary by special grant.

Commendably, the largest number of motions are concerned with social insurance and industrial welfare, and several refer to safety regulations—the Engineer Surveyors' Association calls for efforts to standardize and simplify regulations—and more data are asked for in respect of accidents at work, a serious problem remembering the heavy increase in industrial accidents noted in the last report of the Chief Inspector of Factories.

Education is to be discussed in the terms of five motions. Arrangements now made for technical education and training are severely criticized. Part-time educational courses by the technical institutes is thought to be an essential part of workshop or office training. More than one motion will ask that day release from employment for such training is made obligatory.

The expected decision of the TUC to seek expulsion of the Electrical Trade Union shows signs that the Council is going to assert its leadership in the movement. Perhaps the next step can be the initiative to reduce demarcation strikes to a productive solution.

Rising Accidents on the Road

The announcement last week of the 1960 road census shows that motor traffic on the trunk and class 1 roads of England and Wales has increased by more than 62 per cent in the past seven years, and more than 37 per cent in the past five years.

Moreover, the number of fatalities on the roads has increased by 6 per cent during the first six months of this year compared with the corresponding period last year. This seems to nullify one of the original claims for the Ten Year Test—which has now been in operation for the last six months—that it would reduce the number of accidents.

Although the test has tidied up the cars on the road, the failure to reduce accidents emphasizes that the judgment and care of the driver is the main factor controlling the number of accidents.

The large increase in traffic makes the maxim "Keep Death Off the Roads" all the harder to fulfil and it is to be hoped that the findings of the Road Injuries Research Group will be heeded by vehicle manufacturers. The group was set up in June last year and a report of their findings during the first ten months has recently been published. With their base at the Birmingham Accident Hospital, there is ample opportunity to examine road accident fatalities and make a detailed analysis of the in-patients.

In the majority of cases the severity of the accident would have been greatly reduced if projections on both the outside and the inside of the car could have been reduced to a minimum—a sound reason for getting old cars off the road—or if some form of efficient safety harness with strengthened seat fastenings had been used. Having built up some form of analysis, and a number of field workers, the Group plan to develop the approaches already begun and to extend the survey outside built-up areas.

Perhaps one way of overcoming the hazards of the road is shown by the continued tendency for Londoners to go Underground. Census figures issued by the London Transport show a rise of 4 per cent in the number of passengers travelling on the Underground during the rush hour at the end of last year. The loss of rush hour traffic on the bus services, due to congestion and staff shortage, is more than compensated by the increased rail and Underground traffic. London's proposed new Underground—the Victoria Line—would never be found unremunerative in a comprehensive balance sheet.

of HP 115's Flight at Bedford

Supersonic air travel for the public—whether they want it nor not—was taken a stage further last week when the Handley Page HP 115 arrowhead research aircraft made its first flight.

For some time Handley Page has been working on the design of supersonic aircraft in association with several other British constructors. Cruising speeds as high as Mach 3 are contemplated. The HP 115, however, is not itself supersonic—it flies at no more than 300 mph—but is designed as a research aircraft to study handling characteristics, stability and control to be expected from a very high speed aircraft at low speeds such as during take-off, approach and landing.

With only a 20 ft wing span, the HP 115 is claimed to be the world's slenderest delta wing aircraft. At the RAE airfield at Bedford it recently flew for 31 minutes during which time it functioned perfectly. A Bristol Siddeley Viper engine of 2,000 lb thrust is fitted centrally at the top of the fuselage in front of the tail.

This aircraft will back up the work Handley Page is doing in their wind tunnels, where flexible models of various supersonic layouts have been tested to determine flutter speeds and to show how structural distortion affects stability and control.

SBAC have announced that if the test programme permits, the HP 115 will be seen at the Farnborough Flying Display. Meanwhile, as Mr. Godfrey Lee, deputy chief designer of Handley Page has said "No one else in the world, so far as we know, has tried out a promising supersonic airliner design in a real aircraft."

Implementing a Gas Grid

The overall conclusion of the Select Committee on Nationalized Industries is that gas must be produced more cheaply (by as much as 4*d* per therm) if it is to compete satisfactorily with other fuels. This is a reduction of 30 per cent and it is thought that it can only be reached by a national gas grid with very large centralized production plants. The committee proposes that a thirteenth board should be set up to join the twelve area gas boards in this overall proposition.

In their report, the large scale gasification of coal by the Lurgi process comes in for some criticism, since the cost of production is still above the figure of 8*d* to 8½*d* per therm which the Gas Council have specified as the required price of gas delivered to the boards. At present the Westfield cost is about 9·64*d* per therm and the estimated figure for the proposed plant at Coleshill—"a dismal story"—is 11·25*d* per therm. The import of methane seems slightly more promising, yielding an enriched gas for sale to the area boards at about 7½*d*, that could be reformed to towns gas for sale at about 8½*d* to 8¾*d*.

No mention of the import of methane would be complete without a reference to the "slight contention" between the Gas Council and the National Coal Board and to the use of oil in gasification plants. The Committee comment "they could not fail to notice that relations between the Gas Council and the National Coal Board have at the best been wintry."

The outcome of all this is that more money must be spent on research. "Even now at its peak," the Committee believes, "expenditure on research is too low in relation to the industry's annual turnover." Much of the production is still based on 19th century methods and new ideas are needed. If Lurgi plants are to become economically practicable, they must be larger, bringing with them increased engineering problems. The gas industry, along with the nuclear power, oil and other process industries, have many similar problems to resolve and—whatever rivalries there may be commercially—technical cross-fertilization could benefit them all.

and a Growing Water Deficiency

The hydrological survey of the Essex rivers and the basin of the Stour have shown that, by 1980, there will be a deficiency in supply of 30 million gallons a day. The current demand is 114 million gallons per day and it is expected that this figure will rise to 158 million, while the greatest increase that is possible in supply, by the total development of all resources within the area, is only 14 millions.

The survey covers one of the driest areas in Britain and is the third in a series being made on the recommendation of the Central Water Advisory Committee for the Ministry of Housing and Local Government. It is entitled *Hydrological Survey of the Essex and Stour Basins* and is obtainable from HM Stationery Office (£1).

In the exceptionally dry catchments of the area, the mean summer rainfall is found to be seven inches short of the mean average evaporation. Of the 30 million gallon daily deficit, the survey shows that perhaps a third might be found by greater re-use of water—certainly every kind of purifier and condenser that can be employed ought to be. More, too, might be done by industry to determine just what its water requirements are, not only in terms of quantity but in quality, for by no means all processes call for best quality drinking water.

The report concludes that there can be no doubt that, in the area covered, water resources have been developed almost to the limit. The inevitable inference is that a water grid will have to be begun, though whether best as a major pipeline or as an open canal awaits further debate.

Accelerated Freeze Drying of Foods

The Danish firm of A/S Atlas have recently given details of how they have contributed in the development of the accelerated freeze drying process for foods.

In 1942 extensive research was initiated in the Copenhagen laboratories of A/S Atlas on the factors determining the retention of the important biological factors and also of the taste and smell in foodstuffs during dehydration and storage. This article is based on two papers by Dr. Tech. Ettrup Petersen of A/S Atlas.

The answer to problems was drying in vacuum, and experiments with this process were, therefore, initiated in 1943. However, it was soon found that a number of difficulties had to be overcome before an economic procedure could be reached.

The main obstacle in vacuum drying is that the drying time is essentially longer than that for air drying, due to the fact that no heat transfer medium is available and that the calories necessary for the evaporation must, therefore, be transmitted through contact to a heated surface, through radiation or through high frequency heating.

These three possibilities were all investigated but radiation heating was soon given up due to the fact that the heat penetration of an outer layer of fully or partly dried material was too low to prevent a build-up of impermissible high temperatures, before the evaporation in the inner parts of the drying goods could absorb the heat generated. Discoloration and scorching resulted, and the products were rendered useless.

High frequency heating is apparently a very appealing way of applying heat to a material being dried under vacuum, as the energy absorbed is directly correlated to the dielectricity constant of the matter exposed. However, two reasons speak strongly and decisively against high frequency heating. The first is that the efficiency of the generators is too low to permit economic operation, and the second is that the conductivity of the air at high vacuum is sufficient to permit corona formation, resulting in scorching the material.

The only possibility left after this was heat transfer by contact between the drying material and a heated surface, but this apparently simple method also presented difficulties.

It is well known that dried foodstuffs, like vegetables, fish or meat, have a very low heat conductivity, due to the fact that they are very porous and, as the heat will have to penetrate from the outside, the outer layers will dehydrate first and thereafter represent an efficient barrier against penetration of heat to the inner layer of the drying material, thereby prolonging the drying.

Another difficulty is that many foodstuffs, when placed on a plain tray, will have relatively few contact points to the surface, and an even transfer of heat to the bulk of the material is, hampered.

In order to overcome these difficulties, attempts were made to press the material against the heating surface during the drying, and through this procedure considerable improvements in heat transfer were arrived at. Further gains were obtained by placing the material between two heating plates, which could be moved towards each other, thus exerting a pressure on the drying material. Thus *accelerated* freeze drying was established. This process is protected by a number of patents. Using this method it was found that drying of a 22 mm thick fish fillet could be reduced to about 6 hours as against 16 to 48 hours by one-sided contact without pressure.

When drying certain materials, such as spinach, it was observed that the material could collapse to such an extent that the vapours could not escape to the condenser, but this could be efficiently counteracted through inserting wire netting between the trays and the drying material, which provided adequate pathways for the vapours to escape.

In 1946 the first commercial vacuum contact plant was established in Aalesund, Norway, primarily for the drying of fresh and salted codfish. This plant, which is shown in Fig. 1, consisted of a cabinet which could be evacuated by means of a water jet ejector to about 25 torr.

Twenty-four heating plates, each 2·5 m by 1·20 m, were arranged in three sections, being independently suspended in moving bars, so that the spacing between the individual plates could be varied between 10 mm and 35 mm. The plates were completely counterbalanced and the distance between either two plates in a section was at any moment the same. The moving bars were actuated through upper levers, which were turned by hydraulic action in such a way that a controlled pressure varying from zero to 5,000 kg per sq. m could be exerted on the drying goods.

The heating took place by means of hot water being circulated through the multi-labyrinth

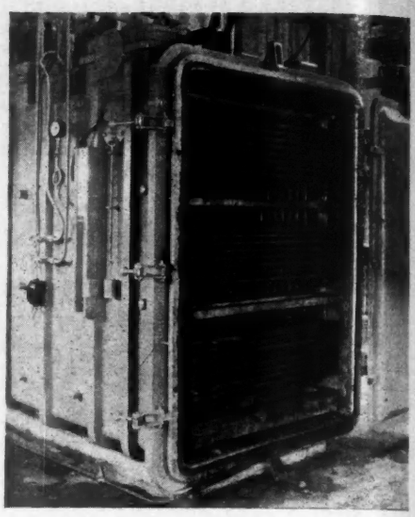
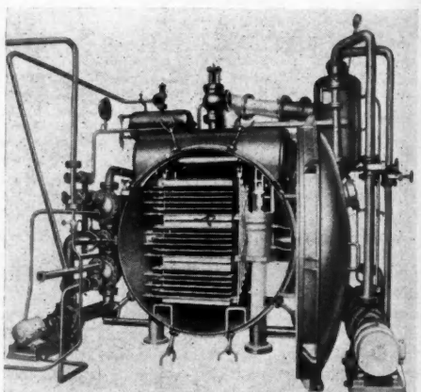


Fig. 1 This commercial vacuum contact drying plant was established in 1946 at Aalesund in Norway, primarily for the drying of fresh and salted codfish.

Fig. 2 A later type of plant in which the cabinet has been given a cylindrical shape, ideal for withstanding the heavy outside air pressure when being evacuated.



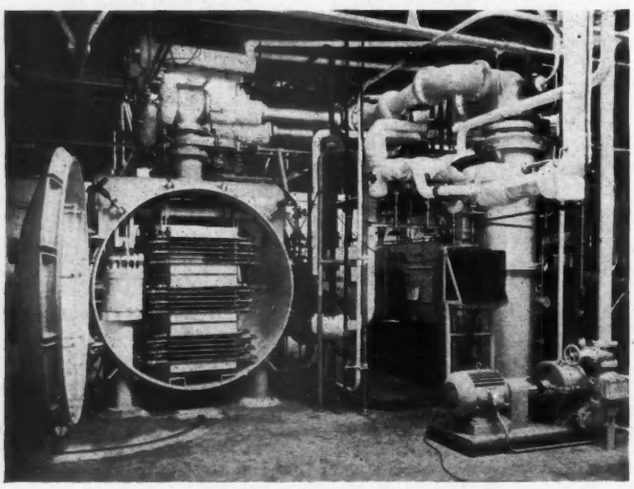


Fig. 3 This Atlas freeze dryer was supplied to Armour and Company, Chicago, and was installed in the British Ministry of Food Experimental Factory at Aberdeen.

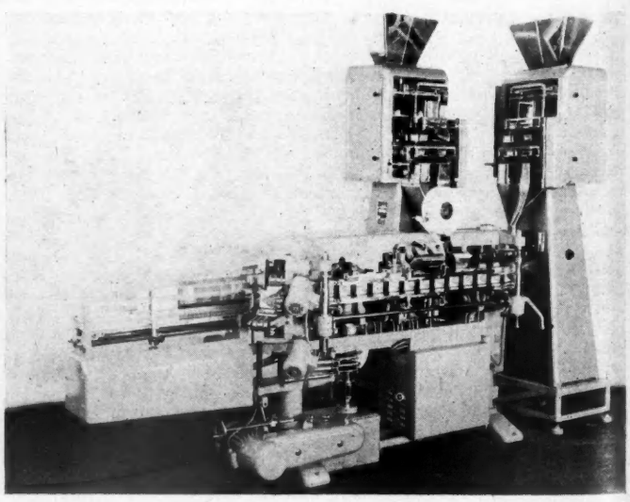


Fig. 4 An "Expresso" automatic packing machine with two weighing devices.

plates with temperatures varying from 140° C to 20° C. The raw material was placed on aluminium trays, which were then placed in a rack car, from where they could be pushed into the cabinet between the heating plates in one operation.

After closing the front door, the vacuum was applied and the heating started. The vapours were condensed in a spray condenser by means of sea water.

The results reached confirmed the indications of the laboratory experiments, as drying times of 6 hours for fish fillets were readily obtained.

In the meantime, research was carried on in Atlas laboratories, and it was found that, by increasing the vacuum, the quality of the products could be improved, even if the drying times could not be diminished, and a pilot plant furnished with steam ejector, condenser and vacuum pump was tested.

When in 1950 a plant was delivered to the Experimental Factory of the British Ministry of Food for erection in Aberdeen, this system was incorporated. The main construction of this cabinet was identical to the Aalesund one, but the vacuum system consisted of a steam jet ejector, a spray condenser and two water jet ejectors.

During the preliminary tests of this plant, it was found that vacua of the order of 2·5 Torr could be obtained, so that it was possible to freeze the raw material before the drying and, if the sea water was very cold, and the load on the condenser modest, vacua of even 1 Torr could be reached. This led the process directly into freeze drying.

In several plants delivered in the following years, the same type of vacuum plant was adopted, as can be seen from Fig. 2. In order to avoid the heavy stationary equipment for loading and unloading the trays, the size of the cabinet was reduced, so that 18 heating plates of 1·50 m by 0·75 m surface were available for the process. Furthermore, the cabinet had been given cylindrical shape, as this is, of course, the ideal design for withstanding the heavy outside air pressure when being evacuated. In addition, the packing problems of the front door are greatly facilitated.

Fig. 3 shows a freeze drying plant with movable heating plates which was installed in the British Ministry of Food Experimental Factory at Aberdeen by Armour and Company, Chicago. The plant was designed and manufactured by A/S Atlas.

The cabinet is of cylindrical shape. At either end there are hinged doors with wheel-clamps which provide the initial seal, and the external air pressure which provides a sealing force of about 40 tons, together with a specially designed vacuum seal ensure tightness during the high vacuum period.

On top of the cabinet there are two compartments for the levers from which the heating plates are suspended by individual bars. The heating plate motion is activated by a hydraulic cylinder which is situated inside the cabinet. By means of this system pressures of up to 8 lb per sq. in of tray area can be exerted on the product.

As the total hydraulic system, including cylinder, levers and moving bars, is located inside the cabinet, no shafts have to pass through the cabinet shell, thus eliminating the risk of leaks. Spring supports are situated between the heating plates and the moving bars in order that unevenness in the layer of material to be dried can be absorbed without causing deformation of the heating plates.

With the cabinet shown a great number of test runs have been performed on many different varieties of meats, fish, vegetables and fruits and operation charts for the manufacture of highly satisfactory products have been obtained.

It has been found that vegetables could in many cases be frozen in the cabinet proper causing a self-evaporation of 16 to 18 per cent of the water content; whereas such freezing by the vacuum would cause surface case-hardening and discoloration of fish, meats and a number of fruits.

Utilizing a thickness of 20 mm of the raw material, drying times of about 6 hours have been proved.

Packaging

Automatic or semi-automatic machines for packaging freeze dried products have been developed in Sweden and such a machine is shown in Fig. 4.

The products are filled into moisture proof bags and 80 per cent of the opening of the bag is thereafter heat sealed. The bag is then evacuated and flushed twice with nitrogen. It is then finally sealed, leaving a slight vacuum in the bag causing this to fold firmly around the products which are thereby located safely in their place. The plastic bags are packed in printed cartons, which at the same time protect against the influence of light. In this way the shelf life of the materials will amount to several years and the advantages over frozen products in storing and handling are obvious.

Future

Today accelerated freeze-drying is an established process for handling food-stuffs in bulk and a number of well-known companies have included this procedure in their manufacturing programme.

New developments in the mechanical design will aim at lowering the manufacturing costs through more mechanized handling and transportation of the materials, through more efficient vacuum plants and by increasing the capacity of the plants in proportion to the installation costs.

For the food manufacturer the field is clear and opens unlimited possibilities with respect to preparation of ready-to-cook dishes, separate ingredients for mixed foods and instant drink powders.

The accelerated freeze drying which took 17 years to develop can therefore be considered as one of the most promising developments in food preservation and certainly here to stay.

A/S Atlas, Baldersgade 3, Copenhagen N, Denmark.

The Stalwart Cross-Country Amphibious Carrier

Though developed as a private venture the War Office is keenly interested in the new Alvis Stalwart load carrier.

Success with the FV 600 series fighting vehicles and the Salamander fire crash tender chassis, now in service throughout the world with British and other armed forces, has encouraged extending the range with a load carrier. The results of these investigations is the Stalwart.

The vehicle, which has a civilian type cab and a simple drop-sided cargo area superstructure, will be superseded by Prototype 2 which will have a number of improved design features. In the absence of a known specification for a wheeled 5 ton load carrier it has been necessary for Alvis to anticipate many of the requirements for such a vehicle. The Stalwart is transportable by air in an Armstrong Whitworth Argosy and similar cargo aircraft.

The Stalwart is a frameless vehicle with a boat-shaped waterproof hull mounted on six independently sprung wheels. The wheels are sprung on torsion bars and are damped by hydraulic shock absorbers. It is powered by a Rolls-Royce B81 engine of 220 bhp; from there the drive is taken to a central transfer box which incorporates a NoSpin differential, thence out to bevel boxes adjacent to the centre wheels, from which torque shafts run fore and aft to each front and rear wheel. Each wheel hub houses an epicyclic train which provides the final gear reduction to the wheels.

This traction system gives the Stalwart an overground performance superior to any wheeled vehicle and the equal of most tracked vehicles. Demonstrations in fact show it to be better than a tracked vehicle when it comes to crossing deep water. In addition, because it is wheeled it is quiet in its movements, there is minimum of crew fatigue and a virtual absence of damage to roads and lines of communications.

Steering of the two front and two centre wheels is by positive mechanical linkage, hydraulically assisted between the steering wheel and road wheels. In water steering is manually controlled from the steering wheel which is coupled to the port and starboard ducted propulsion units. These are Saro/Gill units mounted one on each side of the hull approximately above the rear wheel.

The Stalwart has a waterproofed hull. In the water it is said to be capable of speeds in excess of 5 knots. Initial trials have shown that it can make headway in the water by the power of its wheels alone. After further trials Alvis plan to drive a Stalwart with a crew of two from England to a point in Germany, crossing all land and water obstacles on the way including the English Channel.

Speed on the road is a maximum of 45 mph and the range is 450 miles. Cross country it is said to prove equal to known track vehicles of similar capacity. It has successfully surmounted a vertical obstacle of 1 ft 6 in high, and a trench crossing of 5 ft 9 in.

Dunlop disc brakes are fitted; one brake to each of the two front wheels and a pair of brakes to each of the other four wheels. These heavy-duty servo-assisted brakes have 16 in diameter discs and are mounted outboard.

Alvis Limited, Holyhead Road, Coventry.

The Alvis Stalwart is a six-wheeled amphibious load carrier that can cross rough ground with the facility of a tracked vehicle. It can cruise at 45 mph, and can take to the water and swim at 5 knots. It is also transportable by air in the Argosy and similar aircraft.

Oil Contamination Can be Eliminated

Oil pollution can still occur around the coasts through accidental spills. Complete clearance is however possible and Esso Petroleum have issued two reports based on their own experience.

DURING 1960, two serious oil spillages occurred from tankers moored at the marine terminals of Esso refineries at Milford Haven and Fawley. The utmost was done to minimize contamination and then to ensure that the areas which were contaminated were cleaned as quickly as possible.

This article is based on two reports issued by Esso on these spillages describing the action taken to minimize contamination and to clean up afterwards. They make a useful contribution to finding a practical solution to the problem of removing oil pollution from beaches, from the sea and inland waterways.

Milford Haven

Following fire and explosions on board ship on 9 July, 1960, a quantity of crude oil escaped from the Esso Portsmouth which was discharging at the Milford Haven marine terminal. The oil was deposited by wind and tide on both shores of the Haven and a small quantity of oil escaped from the Haven and contaminated a bay some distance southwards on the coast.

Although the mobilization of equipment and manpower for the necessary clean-up was hampered by the fact that the spill occurred at a weekend, work was put in hand immediately. Floating contamination was cleared within a few days but the large scale operation for the cleaning of contamination from the cliffs, beaches and vegetation occupied ten weeks.

Floating contamination, where heavy, was removed by corralling the oil within spill booms and thereafter manoeuvring it to a suitable position on shore where it could be drawn up by vacuum pumps into tank trucks for transportation to the refinery. When this method reached its practical limitation as much residual oil as possible was collected on loose straw and carried away for burning. All other floating contamination was destroyed by the use of emulsifiers which, by breaking down its surface tension, transformed it into a freely miscible emulsion which dispersed in the water. No use was made of chemicals which are alleged to sink floating oil nor were laboratory experiments carried out on the same.

On shore, unsuccessful attempts were made to remove oil from the beaches by burning it with flame guns. These were abandoned when it was found that tarry residues remained and that the process was unduly expensive in effort. Ultimately all beaches, cliffs, rocks and mudflats were cleaned by the application of emulsifiers, followed by water washing. Seaweed and other contaminated vegetation was cut and removed for burning.

The operation was 100 per cent successful and it was established that the complete clearance of crude oil is entirely practicable. It was demonstrated also that the sooner oil is cleared the easier and cheaper is the operation, since the heavy fractions are less easily emulsified once the light fractions have weathered off.

By good public relations with both authorities and private individuals, and with cooperation from every source from which it was needed, the operation was carried through to its conclusion.

Fawley

The other accident covered in the reports concerns a spill from a tanker discharging at the Esso Marine Terminal at Fawley.

In the early morning of 15 September, 1960, a large spill of bunker fuel oil, estimated at 116 tons, occurred from the seaward side of the tanker Bideford. Bunkering was stopped immediately andthe oil stopped running overboard. Considerable pollution resulted in the Southampton Water and Solent area.

To gain a quick appreciation of the extent of pollution of water and of beaches, arrangements were made for surveys of the whole area to be carried out. These surveys showed that there were considerable quantities of oil on the waters of the Solent for two days after the spill. An aerial survey showed that our action should be directed entirely to the beaches. Aerial surveys were found to be important in that they enabled us to use the available manpower at points where it was apparent that heavy pollution had occurred.

A detailed survey of the whole of the beach area likely to be affected was carried out on foot by 20 experienced refinery supervisors. This survey covered 50 miles of beach.

After most of the cleaning up had been completed, a second detailed survey of the Solent and Southampton Water shores was carried out by refinery personnel.

A number of other visits were made at different times to badly polluted areas and information was also received from local authorities about the condition of the beaches in their areas and from refinery personnel involved in the cleaning-up operations.

It was decided that contact should be made with the various local authorities as soon as practicable and that good liaison should be maintained with them during any cleaning-up operations that might be necessary in their area.

Wherever possible, the use of oil solvents is most desirable. Kerosine extract, with 80 per cent aromatic content, which was immediately available in bulk at the refinery is very effective. Like most normal solvents, however, it is immiscible with water. It can be used in bulk only under conditions where the oil/solvent solution can be separated from the material which has been cleaned. Generally speaking, this limits its use to such operations as the cleaning of yachts, in which rags are soaked in the extract.

Emulsifying Solvents

Where one cannot dispose of the oil/solvent solution, it is necessary to use emulsifying solvents. These have the property of forming a solution with the oil which is then readily emulsified with water. When the water is the sea, in general the oil emulsion is so diluted that for all practical purposes it is no longer a nuisance.

Several formulations were known. One was chosen which had been used with success at Milford Haven, and was readily available.

There was at the refinery 300 ft of spill boom. This was used in the two days immediately after the spill when there was still considerable oil on the sea, to try to retain the oil in patches and then recover the oil from the surface of the sea. These booms proved adequate in slack water. During the first morning, when the sea was calm and the oil patch clearly defined, it was towed quickly into position. But as the sea became more disturbed and the tide increased, oil was swept under the skirt of the boom and was not able to be recovered.

However, some oil was recovered from the water. The only successful method of lifting was to spread dry straw on the surface in order to mop up the oil before lifting it with pitchforks into the recovery barge. This was laborious and time consuming, and in any case within 24 hours the floating oil patches had been largely dispersed by the rising sea. The "Esso Recovery" was swamped by the seas when following the floating oil out of the harbour into the Solent.

The bunker fuel oil was too thick to be lifted by suction nozzles available on the Esso Recovery. A lighter was chartered and loaded with a large air compressor in order to try an experimental suction nozzle, but was too late to be of use. Motor launches sprayed emulsifier on the floating oil and attempted to mix it with the screw but this merely resulted in fragmenting into smaller patches. At this time the oil had been afloat for more than 30 hours and, from the molecular film on the surrounding water, it was evident that considerable leaching out of the lighter components had occurred. Our subsequent experience with this method suggests that it would have been successful if adopted immediately, when the oil was less viscous.

Cleaning the Beaches

The greater part of the coastline affected was hard shingle beach, and contamination was in the form of a continuous band of oil, about 4 ft wide, at the high water mark. Oily debris and weed were collected by hand and burnt. Bulldozers trenched alongside this band, turned in the whole length, then backfilled. In places where access was difficult, or the surface too bad for mobile equipment, a series of holes were dug above the high water mark to a depth of at least 4 ft, and the contaminated material buried.

The most difficult cleaning operations were around the slipways, jetties and sedge of the Fairey Marine foreshore at Hamble. Contamination was at its heaviest here and every known technique was applied by a force of up to 20 men for 16 days. These men were based on the Esso Recovery which moored alongside. Initial mopping up was with straw, and burning and burying was then followed up by spraying with an emulsifier. Once the heavy contamination was cleared, it became evident that fresh oil was being deposited with each tide. The oil causing this recontamination was being washed from the sedge on either side. Accordingly, all oily rice grass at the high tide mark was cut down with sickles and burnt. The stubble was then treated with flame guns, after assurances from a marine biologist that no permanent damage would be sustained by the roots.

Refinery forces were withdrawn from beach cleaning on 7 October—23 days after the spill—at which time all contamination, except for a small amount on the Isle of Wight, had been removed.

Contamination to yachts, their gear and equipment occurred. The following materials were distributed from three yachting centres together with instructions on how they should be applied. (1) Aromatic extract—was readily available and was distributed in small cans for cleaning badly contaminated hulls, superstructures and cordage. (2) Solvent emulsifier—as it became available—was used primarily for cleaning shore installations and later for hulls, superstructures and cordage. It was distributed in small cans, one-third full, so that these could be topped up with two-thirds of fresh water to improve the emulsifying effect. (3) A cleanser for the hands and person. (4) Cotton waste.

These materials were distributed during the weekends from launches. At Warsash and at Cowes, an experienced yachtsman and a chemist from the refinery were stationed to organize the distribution of materials, give advice on their application, and to explain the procedure for lodging bona fide claims for damage.

Speed is Vital

In conclusion it may be stated that speed is unquestionably vital in the early stages of clearance. While oil is floating freely on the water or lying thickly enough on beaches to lift off with each succeeding tide, there is the near certainty of pollution spreading. Not only is this a source of worry and nuisance to the public, but the cost of eventual clearance increases.

Plain Words

By Capricorn

CHILDREN sometimes ask adults the most searching and difficult questions, but could any question be more absurd than the characteristic adult's question to a child: "Do you know what you want to be when you grow up?"

The manner in which we ask the question implies that the boy who has already made up his mind is a sensible boy, and one who hasn't is to be pitied. I hope that one day I shall hear a boy retort: "Do you know what the world will be like in twenty years' time?"

I frequently meet men—men who are successful in their business or profession—whose work is quite different from what they had envisaged in their teens. Ruefully they say they never thought they would be doing *this!* Often such a man will reveal a perceptible guilt complex. He seems to be saying that Father, if he were alive, wouldn't approve, but a shrug of the shoulders indicates that, no matter what Father would think, "I've not done too badly." Which is the Englishman's way of saying he has been remarkably successful.

But how many men are there who are plodding painfully and conscientiously in the profession they chose when they were too young to choose? They were pressed into making a decision, believing that the ability to make such a decision early was a mark of manhood. They have been modestly successful, and in middle life they have perhaps lowered their sights, coming to believe that they have only average ability, and settling down somewhat reluctantly content with their lot in this world.

A fearless exercise in self-analysis might reveal that their choice has been based on a fortuitous circumstance—very little to do with their real abilities and mature interests—and that if they had had the courage to make a change in their twenties or thirties it could have led on to greater things.

These wrong choices and too-early decisions didn't matter very much fifty years ago or more, but today they could prove to be seriously frustrating for the individual, because of the intense competition in all professions, and cumulatively damaging to the nation. Even in those cases where a boy is naturally settled and determined in his choice, I believe he ought to have a mental reservation that he will be prepared to make a tactical move at almost any stage in his career. Not only will his interests and aptitudes develop, but the pattern of industry, commerce, education and the role of each profession will change too. The world will require a different complex of skills and intellects in the 1970's than in the 1960's. No one can foresee these changes with any degree of accuracy.

In future I shall not ask a boy that absurd question; I shall ask him what he is going to study and where he is going for his initial training.

Letters to the Editor

The Best Engineer?

SIR, Very few would disagree with the principle advocated in Capricorn's recent Plain Words (ENGNG., 14 July '61, p. 37) but what he is really doing, by implication, is to give his own definition of "the best engineer."

To fulfil the task Capricorn assigns to him, this "best engineer" must be, in effect, the best all-rounder. It is essential that he should have sound technical knowledge of his company's product, or if there are several or many products, a sound background knowledge of them all and a detailed knowledge of one or more of the major ones.

But he must also be a man of many other parts. He will need commercial knowledge and shrewdness, diplomacy, the ability to talk intelligently on a wide range of general and cultural topics, at least one or two foreign languages, and, it goes without saying, a sense of humour. Keeping up to date with the latest developments must have become a habit.

Fortunately for Great Britain, there is at last a more general tendency to adopt the practice always followed by continental firms and to insist that young men of the right type who wish to become commercial engineers should have the necessary education (preferably university) and the practical training and experience to qualify them for corporate membership of the professional institutions.

Properly selected and trained, technical representatives are then able to perform most of the functions of Capricorn's "best engineer," provided they are given the necessary authoritative backing at home. That could be where the "best engineer" comes in.

Yours faithfully,
ALEX. C. HIRST.

The English Electric Company Limited,
Staff Training Centre,
Dunchurch, Warwickshire.
11 August, 1961.

Good Service from Three Dimensional Models

SIR, Anent your article "Use and Abuse of 3-D Model Layouts" (ENGNG., 23 June '61, p. 868), some of the advantages of the use of models would appear to have been overlooked.

Models of any machine may be made quite simply in dental cement. A model of the outline of the machine should first be made in balsa wood and this immersed in a block of liquid low-melting-point rubber which must then be cut carefully after solidification to give an axis involving no re-entrant angles. Having thus made the rubber mould any number of models of that type of machine can then be cast simply in dental cement and if desired painted to the appropriate colour scheme.

Presupposing that apprentice labour can be utilized to manufacture the moulds, the cost of making models then works out at less than 3*d* per model.

Once a model exists for each machine tool in a factory, relaying of machine lines to suit new production requirements becomes merely a matter of rearranging the models to suit operation planning and the drawing office is completely absolved from any work on machine layouts at all.

Instructions to engineering departments for installation are issued quite precisely by means of map references stating the actual machine number. This means that from receipt of operation planning, machines may be moved into position almost within hours with no drawing office delays. Further than this, they may actually be in production within hours if an overhead bus-bar system of conveying power is utilized, with a centralized floor-channel system for providing coolant.

Top-level approval of a layout may be given quite readily by inspection of the model, without management being involved in tedious study of layout drawings.

The fitting-in of a given number of operations within a specified floor area is more readily done with the aid of models and it can quickly be seen whether the equation is possible or whether some machines need to take more than one operation.

Yours faithfully,
M. N. STARKEY.

Oxted, Surrey.
11 August, 1961.

Evolving the Jaguar Engine

SIR, I refer to the letter from Mr. Weslake (ENGNG., 4 Aug. '61, p. 133) complaining that I should get my facts right in my article "Evolution of an Engine—the Jaguar XK." Yet he does not mention one point from the article which is incorrect.

His complaint, in fact, seems to be that I did not mention certain consultations that took place between the Jaguar Company and his own. Perhaps if I had been writing a book on this engine's development, Mr. Weslake might have had cause for complaint, but, in an article of 1,300 words, which had to be cut anyway because of its length, it is surely a little unfair to expect me to mention patents relevant to the engine and any consultations that took place between the Jaguar Company and other organizations.

Yours faithfully,
BRIAN LISTER.

Cambridge.
8 August, 1961.

Fuel Consumption in Cars

SIR, In Professor P. D. Richardson's delightful note, "Fuel Consumption in Cars" (ENGNG., 23 June '61, p. 854), his data indicates a four-to-one variation in gallons per cold start in winter and summer.

This great variation has led me to extrapolate his data outrageously to secure two new characteristic constants for his car as follows:

$$\left(\frac{\text{gallons}}{\text{cold start}}\right) = \left(T_{warm^\circ} - T_{car}\right)\left(\frac{\text{gallons per cold start}}{\text{degree temperature decrement}}\right)^\circ \quad . \quad (1)$$

The last term I assume to be a constant, as well as T_{warm} in the preceding temperature decrement term. Using the ratio of gallons per cold start of 4 for winter to summer, the last term is eliminated, and T_{warm} is approximated from the average outdoor temperature for the respective seasons.

T_{car} winter	T_{car} summer	T_{warm}	gallons per cold start °F
Assumed	*Assumed*	*Result*	*Result*
37·5° F	70° F	81° F	0·0076
37·5° F	75° F	87·5° F	0·0067

The low resulting value of T_{warm}, between 80 and 90° F, leads me to suspect my assumptions, so now I will check on the energy per cold start in the winter. The quantity is 50,000 Btu. Fully applied to "warming," this energy would raise the temperature of engine and water coolant 1,600° F. This is an order of magnitude too high! Where does all that gasoline go?

I conclude that most of the cold start gasoline is not burned to effectively warm up the engine. It is sacrificed in order to obtain adequate carburation of gasoline vapour during a period when the heat balance in the carburettor and intake manifold is inadequate to vaporize more than the most volatile fraction of the gasoline. The automatic choke on Professor Richardson's automobile is probably "warmed up" and the

gasoline fully vaporizing at temperatures such as 80 to 90° F.

His data is compatible with this hypothesis, but would appear incompatible with the concept of "warming up" the entire engine. To test this concept, I suggest the accumulation of data in all seasons of the year and determination of the starred constants in the following relation which extends Professor Richardson's work to include my hypothesis of the nature of cold start gasoline consumption.

$$\frac{1}{(\text{mpg})_{\text{actual}}} = \frac{1}{(\text{mpg})_{\text{warm*}}} + \frac{\text{gallons/cold start}}{^{\circ}\text{F temp decrement*}} \left(\frac{\sum^{s} (T_{\text{warm*}} - T_{\text{car}})}{\sum \text{miles}} \right) \quad (2)$$

It would appear that means to hasten carburettor and intake manifold warm-up might substantially reduce fuel consumption. Hand choking also should offer opportunities for economy if there were included means to index the choke progressively to an open position whenever the operator neglects it.

Sincerely yours,
DALE H. BROWN,
Professional Engineer.

New York USA.
2 August, 1961.

Education Versus Training

SIR, A book recently reviewed (ENGNG., 14 July '61, p. 55) on engineer education raises an important point by contrasting a university *education* with the combination of education and *training* given by a technical college. The point is an interesting one and, as far as engineering (rather than the physical sciences) is concerned, it tends to put the technical college in the more favourable light.

The processes of both education and training go on, or should so continue, throughout life. In the earlier stages, education must necessarily predominate: with increasing years, professional ambitions and responsibilities, training becomes of greater importance. Training might be well defined as "the acquisition of effective experience." That matter of the right man, in the right place, training himself for his work of the present and the future, is of supreme importance.

The value of any education is largely a measure of the degree to which it enables a man to do this, in all aspects. To prolong the emphasis on education beyond a certain point in life is likely to lower the value and ability of the man—in engineering as in other activities—by tipping the balance too far towards the academic outlook. One can easily visualize the state where any latent creative talent he may have possessed could be educated out of existence.

Too much may well have been said about the importance of the non-vocational aspects of a university education, and its associated mystique. This is largely a modern affectation. The older universities in particular have always been vocational training establishments for the more highly esteemed professions: in the earlier years the church, the law, medicine, and the Civil Service; while, later, in Victorian and Edwardian times, they acted as finishing schools for gentlemen.

In spite of this well-established vocational aspect of the university, it became clear that even this education was not enough: that training was needed as well. In almost every profession, a university degree has long ceased to be a qualification—even including that of teaching. Oddly enough, in engineering, the idea that a good grounding in the mechanical sciences can be an effective substitute for real engineering aptitude and experience still seems to survive.

Let us not allow ourselves, as a nation, to be educated out of existence by putting vocational training into a lower category. A recent university movement for teaching the history of science as a bridge between the sciences and the more cultural subjects finds a solution in building up the humanistic aspects of technical or scientific work. "Sermons in stones, books in the running brooks," in fact.

This suggests that the universities' aim of "building up the whole man" may well be most successfully achieved by building on the sound basis of a man's profession, rather than dealing with a disembodied "education" as something detached and different.

The late Sir David Pye (a man of culture, if ever there was one) referred, in his presidential address to the Institution of Mechanical Engineers, to "The yawning gap between the product of a university course and a qualified engineer," and emphasized the importance of closing this gap. We shall never be able to do this so long as the universities maintain their false claim of putting vocational training into a lower category than *education*.

Yours faithfully,
HUGH CLAUSEN.

London NW2.
11 August, 1961.

Eccles Museum

SIR, In the Borough of Eccles there has been opened recently a museum and art gallery at Monks Hall, where we are anxious to assemble as many specimens as possible of the products of local manufacturers, and examples of local industrial development.

We are particularly anxious to obtain, for temporary exhibition or permanent safe custody, items illustrative of the major local developments in the technical sphere. Among these connections are the following:

James Nasmyth. We should very much like to obtain an early steam hammer, as this outstandingly successful machine tool was initially the main cause of this town's expansion in the 19th century, and indeed figures in the Borough's coat of arms.

A. V. Roe. This pioneer in aviation was born in Eccles.

Bridgewater Canal. The canal passes through the centre of Eccles, from north to south, and is another cause of local growth and prosperity. An exhibition to celebrate its bicentenary is to be held at Monks Hall in September, 1961.

Liverpool-Manchester Railway. This railway bisects the town from east to west.

Manchester Ship Canal, which forms the borough's southern boundary.

The Binks Carburettor, which was formerly made in Eccles.

It will be greatly appreciated if any of your readers who are able to help will get into touch with me.

Yours faithfully,
J. F. W. BRYON,
Borough Librarian and Curator.

Central Library,
Eccles, Manchester.
11 August, 1961.

Events in Advance

Physics of Graphite-Moderated Reactors

A SYMPOSIUM on "The Physics of Graphite-Moderated Reactors" is to be held in Bournemouth from 4 to 6 April, 1962, under the sponsorship of the Institute of Physics and the Physical Society with the collaboration of the British Nuclear Energy Conference.

The meeting is intended more particularly for the less senior members of research and developments staffs working in this field. First preferences to attend will be given to members of the constituent bodies of the British Nuclear Energy Conference, one of which, of course, is the Institute and Society itself.

The provisional programme so far arranged includes a half-day visit to the Atomic Energy Establishment, at Winfrith, Dorset. Various important papers have already been promised but the organizing committee is prepared to consider further contributions. Communications should be addressed to the secretary, the Institute of Physics and the Physical Society, 47 Belgrave Square, London SW1. Telephone: BELgravia 6111.

Exhibitions and Conferences

Arranged in chronological order

Engineering Inspection and Non-Destructive Testing, National Conference.—Tues., 5 Sept., to Fri., 8 Sept., at Oxford. Organized by the Institution of Engineering Inspection, 616 Grand Buildings, Trafalgar Square, London WC2. Tel. WHItehall 0818.

European Postal and Telecommunications Administrations, Conference.—Sat., 9 Sept., to Sat., 23 Sept., at Torquay, Devon. Apply to General Post Office Headquarters, St. Martin's-le-Grand, London EC1.

Photomultiplier Tube Applications, Symposium.—Wed., 13 Sept., to Fri., 15 Sept., in London. Organized by the Valve Division, EMI Electronics Ltd., Hayes, Middlesex.

Radio and Television Exhibition, National.—Thurs., 14 Sept., to Mon., 25 Sept., in Paris. Organized by the Syndicat des Constructeurs d'Appareils Radio Recepteurs et Televiseurs, 23 Rue de Lübeck, Paris, 16e.

Network Theory, Symposium.—Mon., 18 Sept., to Fri., 22 Sept., at Cranfield. Apply to Mr. S. R. Deards, The College of Aeronautics, Cranfield, Bletchley, Buckinghamshire.

Hall Harding Exhibition of Photocopying and Drawing Office Equipment and Materials.—Mon., 25 Sept., to Thurs., 28 Sept., at the Old Assembly Rooms, Westgate Road, Newcastle upon Tyne. Apply to Hall Harding Ltd., Stourton House, Dacre Street, London SW1. Tel. ABBey 7890.

Marine Exhibition, International.—Fri., 29 Sept., to Sun., 15 Oct., in Paris. Apply to the Salon Nautique, Port Debilly, Paris, 16e.

Canadian Convention, Institute of Radio Engineers.—Mon., 2 Oct., to Wed., 4 Oct., at Toronto. Organized by the Institute of Radio Engineers, 1819 Yonge Street, Toronto 7, Canada.

Electronics Conference, National.—Mon., 9 Oct., to Wed., 11 Oct., in Chicago. Apply to the secretary, National Electronics Conference, 228 N. La Salle Street, Chicago, Illinois, USA.

Instrument Symposium, Eleventh Annual.—Mon., 9 Oct., to Thurs., 12 Oct., and **Research Equipment Exhibit,** Tues., 10 Oct., to Fri., 13 Oct., at the National Institutes of Health, Bethesda, Maryland, USA. Sponsored by the Washington DC sections of the Instrument Society of America, and other bodies. Apply to the executive secretary, National Institutes of Health, Public Health Service, Bethesda 14, Maryland, USA.

Radio and Electronic Components Exhibition, British.—Mon., 9 Oct., to Fri., 13 Oct., in Stockholm, Sweden. Organized by Radio and Electronic Component Manufacturers' Federation, 21 Tothill Street, London SW1. Tel. ABBey 4226.

Vacuum Science and Technology, Second International Congress.—Sun., 15 Oct., to Tues., 17 Oct., in Washington DC, USA. Apply to Mr. W. M. Welch, 1515 Sedgwick Street, Chicago, Illinois, USA.

Corrosion in the Nuclear Energy Industry, Symposium.—Thurs. and Fri., 19 and 20 Oct., in Paris. The symposium will be held as the 16th meeting of the European Federation of Corrosion and is being organized by the Société de Chimie Industrielle, 28 Rue Saint-Dominique, Paris 7e.

Modern Electronics, Eighth International Fair.—Sat., 21 Oct., to Sun., 29 Oct., at Ljubljana. Apply to Gospodarsko Razstavisce, Ljubljana, Yugoslavia.

Problems of Dimensioning and Strength Calculation.—Tues., 24 Oct., to Sat., 28 Oct., at the Hungarian Academy of Sciences, 9 Roosevelt Ter., Budapest V. Apply to Korszerü Méretezési Konferencia MTA Müszaki Tudományok Osztálya, Nádor utca 7, Budapest V, Hungary.

Drawings for Building, Conference.—Thurs. and Fri., 16 and 17 Nov., at Olympia, London W14, in connection with the Building Exhibition (15 Nov. to 29 Nov.). Apply to the conference secretary, 11 Manchester Square, London W1. Tel. HUNter 1951.

Brighten Racing With Larger Engines

To maintain the public's enthusiasm for motor racing, a new unlimited formula is proposed using production engines. This would provide a testing ground for large capacity engines and promote interest among the American manufacturers.

By Brian Lister

LIKE most other sports, motor racing relies to a great extent for its life blood on its attraction to the public. It is well known that fuel companies subsidize racing car manufacturers to a certain degree, in addition to the tyre, electrical brake and brake lining manufacturers. The latter group of companies support racing car manufacturers by either direct payment of retainers, and/or, bonuses to successful participants.

Some of this support is given because motor racing is a way of obtaining quick answers to technical problems, that will inevitably have to be solved by the companies for ordinary passenger and goods vehicle components. These organizations therefore have the solutions to the problems before they even arise in the normal way.

However, by far the largest amount of money is allocated for publicity, rather than for technical reasons. Everyone, I believe, will be familiar with the large banner type advertisements seen on both BBC and ITV television programmes at car race meetings. If these are placed on a corner, which is likely to appear throughout the season on television screens, it is a relatively cheap form of advertisement. Therefore it is in the interest of many companies to keep motor racing in a healthy state. If the interest in motor sport wanes, and the public do not attend in large numbers, or watch reports of motor races on the television in their millions, no advertiser will spend the large sums they are spending at present in keeping the sport alive.

The single seater Lister-Jaguar was used at Monza by Ecurie Ecosse. It is perhaps typical in appearance of cars that could be expected on the circuits shortly, if the BRSCC proposals are accepted. Note offset driving position, to enable ordinary prop shaft to be used, with low driving seat.

LITTLE VARIATION

There is evidence recently that attendance figures are dropping at all the racing circuits in this country, and the only reason for this is that there is no longer the colour, spectacle and technical interest that existed a few years ago. It is with this state of affairs in mind that the British Racing and Sports Car Club have recently put forward a new racing car formula to the CSI, the sporting committee of the FIA.

A criticism often heard about the present range of racing cars is that they are too small and all look alike, many of them employing the same engine, with the engine invariably fitted at the back of the vehicle. Watching and studying racing of this kind is of no interest to the layman (unless there is an exceptionally close contest), and certainly is of little interest to technically minded spectators.

All the 1961 British Formula 1 cars are small and use the Coventry Climax engine. British Formula Junior cars, while using two different makes of engine, are externally identical to the current Grand Prix cars, and in fact on some models chassis, suspension and body parts are interchangeable.

OPENING FOR AMERICAN MARKET

Mr. Nicholas Syrett (the Secretary of the BRSCC) and I were discussing these points over a year ago. We both remembered that the Italian racing driver and enthusiast Count Johnnie Lurani previously had suggested a Senior Formula, using engines between 2 and 3 litres. This followed his establishing of the Formula Junior. But with the American market in mind since most of the United States production engines are over 4 litres, and also wishing to get away from the almost inevitable rear engine position, we discussed the idea of a single-seater Formula, with no restrictions, except that the engine units should be production engines made at the rate of at least 1,000 a year. This would eliminate expensive Grand Touring car engines like Ferraris, Aston Martins and Maseratis. The capacity of the production units could, however, be unlimited, but must be the catalogued figure. Mild degrees of tuning would be allowed, but nothing that constituted rebuilding an engine. These rules would immediately release the 3·8 litre Jaguar and the Daimler sports engine in this country, the Mercedes engines in Germany, and in America the basic units of General Motors, Chrysler and Ford. It could even stir the interest of the USSR—their ZIL III engine being 5,980 cc.

A low capacity limit of 2 litres would be placed on engine capacity, so that Formula Junior cars would be barred from entering for Formula Senior races on short circuits, where the smaller machines may be at some advantage.

There is little doubt that the Americans would be most interested in this Formula, they could for once enter an International class of racing without having to use foreign engines. They have a large ready made range of tuning accessories for most of their engines.

There is a chance in this formula, as indeed in any, that one engine and chassis combination would emerge as the superior vehicle: this has happened to a certain extent with the Lotus Ford in Formula Junior racing. On the other hand, we saw a most interesting struggle for supremacy three years ago in the United States between the Chevrolet engined Scarab sports cars, of the American, Lance Reventlow, and his compatriot Briggs Cunningham's Jaguar engined Lister sports cars. These two teams battled right the way through one season, victory going to the Reventlow team on some circuits, and to Cunningham's on other tracks. There is no doubt this struggle attracted many spectators to the circuits in the United States, the cars being large, spectacular and fast and originating from completely different organizations and countries.

Motor racing is never inexpensive, but it should be possible with Formula Senior to keep the cost of these very fast vehicles down to a reasonable figure, especially if tuning is kept within quite definite limits. I would expect, if the proposals were accepted by the CSI, that one of the first Formula Senior cars to appear in the country would feature the E type Jaguar front and rear suspension, engine, gearbox and final drive unit. The chassis frame design and body design would be by individual designers and constructors. A typical car would perhaps weigh 14 cwt and in appearance would be similar to the Grand Prix cars of the 1954-55 seasons. This is similar to the W 196 Mercedes and 250 F Maserati cars. Some of the current range of General Motors, Chrysler and Ford engines fitted to passenger cars are quoted as developing over 300 bhp. It is not difficult to imagine power to weight ratios of Formula Senior cars fitted with these engines matching the existing F1 Ferraris.

I hinted earlier that such a formula might well halt the tendency to use a rear engine position. The higher weight of large production engine units is the reason for this. Both the Jaguar and General Motors Chevrolet engines weigh around 5½ cwt, Chrysler and Ford even more, so it is not difficult to see that most constructors would prefer a front engine layout. Having front engined vehicles racing again in single seater form is not necessarily a virtue in itself, and there is no doubt that some manufacturers would experiment with rear engine positions, and one would hope with success. But the difficulties in finding suitable gearboxes, and in achieving a sensible weight distribution, as things stand at present would be very marked.

POINTS IN FAVOUR

The advantages, then, of this proposed new formula are:

(1) Availability of several suitable makes of engine, although it is possible that one or two might ultimately be the most successful.

(2) The engines and spares providing tuning and non-standard parts are kept to a minimum would be available in any part of the world.

(3) The cars would be spectacularly fast, but quite safe as drifting technique could easily be applied, since there would be surplus power available.

(4) This could be the fastest, yet one of the lowest priced formulas ever introduced.

(5) The surplus power in itself would mean that the really outstanding drivers would be at an advantage.

(6) If races of 200 to 300 miles in length were held, it is quite possible that tyre changes would be required, and this would have great spectator appeal.

(7) This is the only formula that has ever been proposed that gives the Americans, Canadians, Australians, and Russians an even chance to develop successful cars at moderate expense.

(8) We now have to wait until September to see if the proposed formula is acceptable to the CSI. Cars would go under the name of the chassis manufacturer, but colour would be added by the name of the engine manufacturer following in the title.

Finally I would like to place on record that it is very unlikely that the acceptance of this formula by the CSI would persuade my company to return to motor racing. My sole interest in pressing for its acceptance is that I believe it would be just the tonic that the sport needs now: an unusual, fast and spectacular formula.

Human Element

Professorial Chair—a Hot Seat

A RECENT academic appointment of particular interest and importance to industry is that of Visiting Professor in Industrial Administration at the University of Manchester's College of Science and Technology. The appointee, who till take up his duties on 1 October, is Mr. Ronald Beresford Dew, assistant managing-director of Production-Engineering Limited, the industrial and management consultants. He has served on the boards of several engineering firms and has just returned from a tour of American business schools, including the doyen of them, Harvard.

Anti-Monopolies

Of his challenging new job, Professor Dew said, "This is an opportunity to distil all that is best in British management in general—and Lancashire management especially—and to bring to bear on industry by close cooperation the really significant contribution which the University has to make." However, if from this harmlessly broad statement it seems that this might be just another do-gooder too respectful of established practice to flutter the dovecots of tradition and complacency, then this impression is swiftly dispelled by the rest of what he had to say.

Attributing any lethargy in British industry to the system rather than the men who must operate it, he considers that the only alternative to an industrial society based on close centralized control is one based on "a true free-enterprise system." In this country, Professor Dew argues, we are inefficient because we have the worst of both worlds. He said, "If you tolerate price rings, monopolies of goods, services, materials and labour and so on, restrictions on output, on apprenticeship and everything under the sun—and this country is riddled with restrictions and monopolies—what other results do you expect?"

Planning

This is fighting talk indeed, and there can be no doubt that a visiting professor with this sort of fire in his belly must do some positive good somewhere, particularly when his teachings are available at first hand to the 500 graduates produced annually by the College of Science and Technology. But one cannot help feeling that the sort of monopolies and the sort of restrictive practices he decries are now so firmly embedded in our industrial thinking that they are protected by tacit, as much as written, agreement. In fact, it would seem that the attitude of mind and, often, self-deception which they inculcate are more dangerous, if anything, than the agreements themselves. Countering this attitude, or malaise, of the mind is partly at least a process of re-education and Professor Dew is well placed—both in his normal role of consultant and in his temporary role of university teacher—to take a leading part in this process.

Like most people connected with industry at the moment, the consultant-turned-professor blames the Chancellor of the Exchequer's stop and start policy (itself one of the abhorred restrictions) for much of industry's present lack of direction and material progress and, together with a clean sweep of restrictions and monopolies, he joins the call for a national five-year plan. In this, of course, he is, at last, in both good and numerous company. The danger here, in fact, is that so many people are now saying just this that everyone feels he is amongst the converted and no one (except, fortunately, men like Professor Dew) feels really missionary about it.

This two-pronged advocacy of "true free enterprise" and of a "national plan" is less paradoxical than it might at first seem in the light of French thinking and policy (ENGNG., 18 Aug. 1961 p. 193) in basing a national plan on the integrated sum of agreed and coordinated plans for individual industries and sectors of the economy. Nevertheless, one wonders whether the radically free enterprise system which Professor Dew appears to advocate is a practical possibility today, when, inevitably, industry is inextricably mixed with political and social implications and decisions, and when, in some industries, the necessary quest for efficiency leads unavoidably to the reposing of economic power, and therefore economic sanctions, with one firm or a small number of firms. The important point, though, is that the monopolies and restrictions which shield the inefficient and inhibit progressive thinking should be attacked—as Professor Dew attacks them—and eliminated.

Sacred Cows

Whether one completely agrees with his views or not, Professor Dew's onslaught on some of industry's sacred (if somewhat covert) cows—another example is archaic national wage structures—must promote and stimulate basic thinking about the organization and direction of industry. This stimulating of basic thinking is, surely, one of the important services that a university teacher can give to industry. On Professor Dew's own reckoning that "over wide sections of British industry we could get a 20 per cent increase in output tomorrow if management and men thought it worthwhile," there seems to be plenty of scope for his evangelizing faith in industry's ability to go ahead quickly once it is unfettered.

Professor Dew's appointment to the Industrial Administration Department at the Manchester College of Science and Technology is part of the implementation of the college's policy of stressing the importance of the universities as providers of managers, as well as of scientists and engineers. Professor R. W. Revans was appointed to the department in 1955, and Professor Dew's post, it is understood, is the first visiting professorship in such a department in a university in this country.

At the college, however, the subject of industrial administration is regarded not only as a practical training in management but, probably even more important, as a vitally useful academic discipline. Its identification of problems, its sorting of the significant from the insignificant, its processing of information, its specifications for action, all in the complex settings of personal and social conflict, make it potentially a subject of major intellectual rigour.

It is considered, in the department, that the university can make three types of contribution to management thinking. One is by research work into various aspects and problems of management to extract basic teachable ideas and relate them to other research elsewhere; the second is to use the results of this research to encourage students to seek the logical structures within which the underlying problems of management may be more clearly identified and progress may be more readily controlled; the third is to study the processes themselves by which managers manage.

Professor Dew's appointment is particularly relevant to this last function, and it will greatly extend the opportunities for academic and industrial staffs to meet in short residential courses.

With Safety as the Background

HM Factory Inspectorate have given their blessing to a course on a range of practical electrical subjects in which the safety factor is important. The course is to be held at Burton Manor College, Burton-in-Wirral, Cheshire, from 15 to 20 October next, and will be attended by engineers from many firms and organizations in this country, as well as from Europe.

The subjects handled by the course will include the electricity regulations; semi-conductors; corrosion; electric shock and fire hazards; earthing; the radio valve as a tool; explosion hazards; maintenance; design of flame-proof apparatus; and the application of radioactive techniques. While the course is not primarily about safety, by treating these subjects with safety as the background it is hoped to inculcate in engineers a method of thought which will result in greater safety in their work and in its products.

An example of this instruction in safety mindedness is to be the last day of the course which will be devoted to a study of static electricity, its application to liquids and solids, and measures necessary to combat it as a potential hazard. On that day the speakers will be Professor J. M. Meek of Liverpool University, Dr. A. Klingenberg, the Shell consultant on static electricity, and Dr. P. S. H. Henry of the Shirley Institute.

The course has been held previously at approximately two year intervals and is organized by the Warden at Burton Manor College.

Better Housekeeping in Steel Foundries

In presenting their first report, the Joint Standing Committee on Conditions in Steel Foundries urge a higher standard of good housekeeping to eliminate dust and reduce accident rates. The committee was set up in 1952, continuing the work of an earlier committee, and reports to HM Chief Inspector of Factories. Its work is still in progress but it has been considered opportune to publish this interim report to supplement and coordinate the individual research reports already published.

A high standard of ventilation is advocated and it is also suggested that, where possible, dustier work should be allocated to periods, such as night shifts, when the smallest number of men are present. The committee have examined and developed various methods of dust control, including the use of vacuum cleaners, water, blasting techniques and local exhaust ventilation, and feel that, though further work is still necessary on these and other techniques, it is clear that more use should be made of them for the protection of dressers. From their investigations, the committee also conclude that dusty working conditions are one cause of accidents.

At this stage, the committee recommend (*a*) more care in the provision and maintenance of better floors and gangways, with particular attention to permanent and temporary obstructions; (*b*) wider use and proper care of protective clothing and devices; (*c*) early first-aid treatment for all injuries; and (*d*) better instruction in safe methods and practices in manual weight lifting and in the handling of loads by cranes and hoists.

They further recommend that a campaign to further these objectives might be best organized through Works Safety Committees composed of management and operators. Many firms already have such committees—some of which badly need a rejuvenating shot in the arm—but many other firms have failed to appreciate their value as a means of encouraging agreement and joint action to improve working conditions (and therefore productivity) and cut down accidents.

Pause for What?

At the moment the Chancellor of the Exchequer appears to be winning his battle for a wage pause. The allegedly white collar workers and the school-teachers might seethe with righteous indignation but they do not have the organization and the militance—particularly, out of term time, the teachers—to carry the day. The same is true of the canteen staff and the waste reclamation workers covered by the rejected Wages Council proposals.

Now industry is waiting for the crunch when the more powerful unions meet the Chancellor head-on. It is assumed that this will be the decisive moment for the Chancellor's policy.

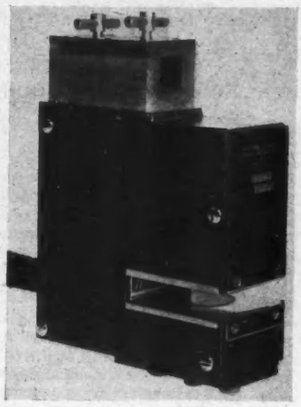
There is also, however, a more incipient danger. A significant feature of wage payments in recent years has been the "wages drift" or "earnings drift" by which weekly earnings have crept ahead of wage rates. This is a drift composed largely of (*a*) overtime payments, very often in low paid industries where they are a means of compensation; (*b*) payments above nationally agreed rates; and (*c*) payment by results, often very loose.

If this has happened at a time when the accepted arbitration procedures have been functioning normally, greater pressure than ever is going to be imposed on this drift factor when these accepted arbitration procedures are suddenly removed. The result will almost certainly be a piecemeal, if grudging, growth of unnecessary overtime, hastily introduced incentive schemes based on loose rates, and a variety of marginal allowances.

In other words, a wage pause, even if it meets with some apparent temporary success, will not stop these back door increases, but will even aggravate them. This will mean that our wage structures will become even more fragmentary and irrelevant to the requirements of modern industry. One imagines that this is the sort of inevitable development that the Treasury type thinking would not know much about.

EDGE-REGISTER CONTROLLER

For Reeling on Mandrels



THIS edge-register control equipment, Series ERC1, provides an economic means of controlling correction devices designed to position the edge of materials to within close limits.

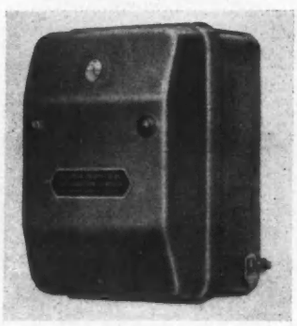
The equipment comprises a photoelectric viewing unit, through which the material passes, together with a remote wall-mounted control unit. Twin photocells observe the edge of the strip or web, the system being arranged so that one cell is obscured and the other illuminated when the position is correct. If the edge of the material moves, the direction of the deviation is indicated by the photocell conditions and the correction arrangements are initiated. After running for a predetermined time, the correction system is brought to rest and the equipment again checks the position, repeating this operation until the edge of the material is restored to the correct location.

There is provision for the adjustment of dead zone over a 4 : 1 range. Accuracy is within $\pm \frac{1}{64}$ in when set to the optimum sensitivity. Correction and observation time delays are adjustable from 0·3 to 3 sec. Two viewing heads are available, having throat depths of 3 in and 6 in respectively.

The equipment operates on 110/115 or 200/250V 50/60 c/s single-phase supplies. *Lancashire Dynamo Electronic Products Limited, Rugeley, Staffordshire.*

LEVEL CONTROLLER

For Conductive Liquids



INTENDED for use with most electrically-conductive liquids, the Resistron liquid level controller is of particular application with various types of acid and in water feed tanks.

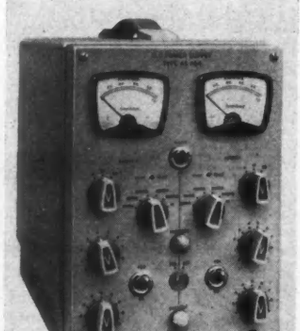
The specific resistance of the liquid concerned should not exceed 50,000 ohms per centimeter cube. In conjunction with a high temperature electrode, the unit can be used for boiler level control, and will give audible and visual alarm as well as taking corrective action when the water in an unattended boiler has fallen to a dangerous level.

The system functions by applying a small ac potential to the liquid through the electrode, and a control voltage is developed across an internal potentiometer network. This is then used to control a thermionic valve which in turn operates a relay. No moving parts are involved in or on the containers, and a full range of electrodes is available. The circuitry is so arranged that, should a failure of the valve or a component occur, the relay will automatically de-energize itself to the "safe" condition.

Models RS500A (high level) and B (low level) employ a fully dustproofed relay with 240V switching, a fixed sensitivity of 50,000 ohms and fail to safe facilities. RS500C is a version with continuously variable sensitivity control and high/low level changeover switch. All models are available for standard mains supplies. *Thomas Industrial Automation Limited, Station Buildings, Altrincham, Cheshire.*

TWIN TRANSISTOR POWER SUPPLY

Overload Resetting



THIS power unit, type AS1164, is suitable for transistor circuit development, and comprises twin 0-30V "floating" supplies, each of 1 A capacity.

Outputs are independently adjustable in 0·1V increments by decade switching. They can be used separately as positive and negative supplies, switched into parallel operation to give 2A capacity, linked in series to provide a tapped 0-60V supply or connected back-to-back to give (± 30V) – 0 – (± 30V). Accuracy of adjustment is ± 2 per cent ± 2 mV.

Each supply has separate overload limit selectors (25, 50, 100, 250, 500 mA and 1 A) and current monitoring meters. A fully electronic proportional control system provides an unusual method of protecting both power unit and circuit supplied. Overload warning indicators are included for each supply. In parallel operation there is one set of over-riding output level controls, but the current limit selectors remain operative and independent.

The stability factor of each output is claimed to be greater than 1,000 : 1, with ripple and noise at 1 mV peak-to-peak and regulation approximately 0·1 per cent at maximum output. Output impedance is less than 0·35 ohms up to 100 kc/s. The unit weighs 25 lb. *Solartron Laboratory Instruments Limited, Cox Lane, Chessington, Surrey.*

TWO-WAY LOADER

Four-Wheel Drive

RECENTLY introduced was the improved Mk II version of the Merton 454 54 hp four-wheel drive overloader illustrated here.

This machine, which is said to be the only four-wheel drive "straight-line" loader available with fully controlled height of discharge at front and rear, has an improved bucket design and digging arms and a more advantageous crowd angle of 40°. The design also features a longer wheelbase, giving better stability and digging power, and a 360° field of vision is possible at front and rear. Bucket capacities which can be supplied are from 1 cu. yd to 2½ cu. yd, according to material to be handled. Normally a 1¼ cu. yd bucket is supplied.

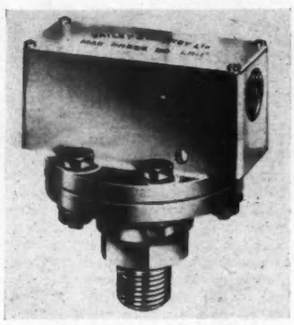
It is claimed that, in using these hydraulic two-way loaders, it is possible to load bulk material more rapidly, as the overloading technique eliminates unnecessary turning and manipulating operations. This consideration also implies that the machine can be operated in narrow and confined sites, where a forward-working shovel could not function.

Because unnecessary turning is avoided, there is consequently less wear and tear on the front axle and steering gear, as well as on the clutch, transmission and tyres. This has been attributed to the fact that, in the overloading method, only half the number of gear changes are required, and the distance the machine has to travel will be less than half that of a front-end loader.

Other features which are brought out in this latest model include power steering, a heavy-duty clutch and lighting equipment—provided as standard. A torque converter drive is available as an alternative system. This type of unit is of interest to County Councils, Rural Councils and Urban District Councils. *Merton Engineering Company Limited, Faggs Road, Feltham, Middlesex.*

PRESSURE SWITCH

Variable Differential



A NEW medium-pressure switch, the Model 108V, makes use of pressure to exercise control, or itself controls pressure.

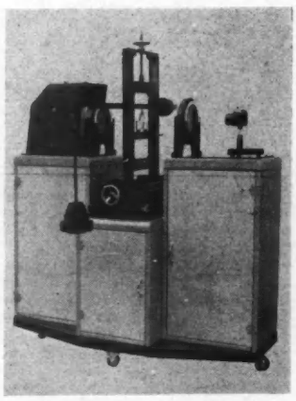
Typical applications are for operating independent domestic water supply systems, brewers' equipment, in pneumatic installations generally, in sulphuric acid filters (for switching off pumps when filters become clogged), for diesel engine oil controls, air compressors and canteen equipment (switching off the electrical elements in hot water boilers).

The variable differential is provided by a controlled spring arrangement between the diaphragm and switch and, as with the position of the switch itself, is adjustable to installation requirements. The differential is altered by the rotation of a drilled wheel inside the case and the switch is adjustable by means of a nut. The range of the adjustment of the differential is from the standard differential to 95 per cent of the working pressure, and its accuracy is said to be within 1 per cent of the maximum pressure. Two circuits are provided, one to close and the other to open at the set pressure.

High, medium, low pressure and vacuum versions cover maximum pressures of 400, 150, 50 and 15 lb per sq. in respectively, with minimum differentials of 5, 3, 1 and ¼, and maximum differentials of 380, 145, 49 and 14 (to 28 in Hg vacuum) lb per sq. in, respectively *Bailey and Mackey Limited, Baltimore Road, Birmingham 22B.*

POLARISCOPE

Dual-Purpose Instrument



THE SHARPLES 5½ in diameter polariscope is claimed to be unique in that provision is made for using it either as a diffused-light or as a transmission instrument.

When using it as a diffused-light type, the light sources are a 60W sodium-vapour lamp, for producing monochromatic light, with two 150W tungsten-filament lamps for white light illumination. Polaroid discs and quarter wave plates can be rotated separately through 360° as required, their rotation being conveniently read off on scales fixed to their housings.

To convert the polariscope into a transmission type, it is only necessary to replace the lamphouse with a platform which carries a 250W compact-source mercury-vapour lamp, a 150W tungsten-filament lamp, and a 6 in diameter condenser lens. The last-mentioned lamp can be brought into use by swivelling a mirror into position, which then has the dual purpose of directing the white light through the condenser lens and at the same time screening off light from the mercury-vapour lamp.

At the other end of the polariscope, a sliding-bellows mounting is provided to carry the camera lens, which then serves as a projection lens. *Sharples Engineering Company (Bamber Bridge) Limited, Hillcrest Works, Chorley Road, Walton-le-Dale, Preston, Lancashire.*

MANUAL ROBOT

Manufacturing Aid

THE TRANSFEROBOT 200 is claimed to be able to perform virtually any repetitive task associated with hand and arm motions, and to be within reach of small manufacturers.

It is said to be the first general purpose automation machine available as a standard article obtainable from stock, and to be far less costly than special-purpose machines. Simple mechanical adjustments enable the device to be easily and quickly applied to different work. Programming of the machine is reported to be learnt within one hour.

The machine, under the control of a self-contained electronic brain, consists of an arm and an actuator, which can be fitted with mechanical, pneumatic, magnetic, and other fingers able to handle different components. Varying forms of jaws are also available. By the use of an accessory swivel the machine acquires a wristing action, and is able to perform almost any required motions within the limits of its reach. It is reported to pick-up, turn over, insert, transfer, shuttle, rotate, and place objects with precision.

Existing applications include processes in the manufacture of clocks, typewriters, motor-car parts, and electrical equipment.

Electronic controls enable any number of machines to be coupled together, to synchronize other similar machines, or to operate associated equipment.

Operation is by a 108-120V 60 c/s supply. Current required is 0·8A. Typical operating speeds are 1 to 50 strokes a minute.

Any failure is on the safe side. *US Industries Inc. (Great Britain) Limited, 1-5 New Bond Street, London W1.*

LENS GENERATOR

Automatic

THE Radmaster automatic toric lens generator shown here has been developed to accommodate precision optical requirements with simplicity of operation and maintenance, and without complicated control equipment.

This unit is said by the manufacturers to possess a higher output over previous models by virtue of its automatic operation, while its simplicity of setting enables two or more machines to be handled by one semi-skilled operator.

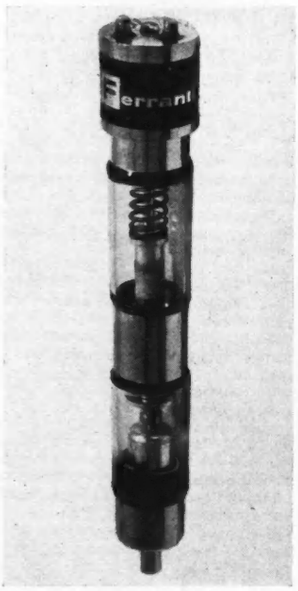
Positive thickness control is obtained by a built-in clock indicator, and a disc-type thickness calculator is incorporated to permit quick marking-up of the work ticket.

Power traverse to the diamond tool gives a constant performance, speeds being varied by electrical selection. A power slide setting to the tailstock reduces setting time and operator fatigue, and prism control and lens holding methods continue the manufacturers' established system based on the electric blocker.

Base plus and minus range is from − 03·00D/09·50D to + 03·00D/10·00D, that for the cylinder being − 14·00 to + 15·00D. The unit can also be used for spherical-surfacing up to − 09·50D and + 10·00D. Exposed and working parts are fully protected against glass powder. A hand model "B" is available, without power traverse and in a untility form, for the smaller workshops. *Autoflow Engineering Limited, Lawford Road, Rugby, Warwickshire.*

VACUUM SWITCH

For Pulse Length Switching



A VACUUM switch designed primarily for high-voltage pulse-forming network switching in radar modulators is now announced. Designated as type 13VSB1, it has been developed to enable pulse lengths in airborne radar equipment to be changed easily.

It comprises a glass and metal vacuum envelope containing two contacts—one fixed, the other movable—both insulated from the earth end to withstand a maximum pulse voltage of 15 kV. The moving contact is actuated by a solenoid against a spring load, which holds the contacts closed. Maximum pulse current is 100 amps, dc test voltage 30 kV, operating time 5 milliseconds maximum, contact resistance (closed) 0·02 ohms maximum, capacity between contacts (open) 1·5 pF maximum. Solenoid ratings are: 24V dc supply, coil resistance 20 ohms ± 10 per cent, pull-in current 1 amp maximum, hold-in current 100 mA maximum.

Overall length is 6 in. *Ferranti Limited, Hollinwood, Lancashire.*

REMOTE-WORKING COMPUTER

Telephone Line Operation

STANTEC electronic computers can be operated from a distance over a telephone line.

Data transmission links can be established on either telegraph or telephone circuits to provide a rapid exchange of data between widely-separated data-handling machines and thereby eliminate the cost of delays associated with the physical carriage of data.

Low-speed links normally use telegraph circuits but for higher speeds of transmission the wider-frequency band available on telephone circuits is necessary. With the appropriate equipment, signalling speeds of 1,000 bauds (1,000 pieces of data per second) or more can be achieved on suitable circuits.

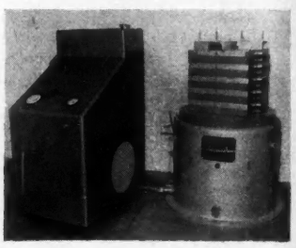
A pre-programmed computer can provide: the summation of numbers; the determination of the arithmetical mean of a batch of random numbers; the sorting of random numbers in ascending order.

The requisite instructions for selecting the programme appropriate to the problems are punched on the source-data tape. A five-unit code is used in preparing the tape. The output from the tape reader is fed to the logic equipment and there converted from parallel to serial mode with two items of data added to each character for protection purposes.

The data output from the logic equipment is applied to a data transmission unit connected to a post office line. At the computer station each received character is automatically checked, reconverted to the parallel mode and passed to the computer. *Standard Telephones and Cables Limited, Connaught House, Aldwych, London WC2.*

VIBRATION GENERATOR

Very Low Frequency



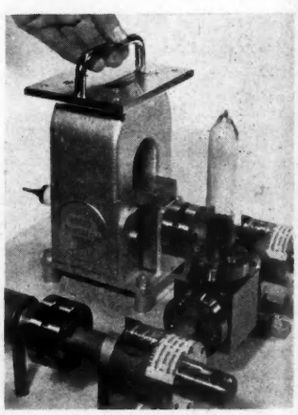
EQUIPMENT has been produced for the testing of components under conditions of vibration, which at the simplest requirement calls for the generation of a large thrust at frequencies down to nil c/s over a long stroke.

It is claimed for this vibrator that it does not suffer from the drawbacks of mechanical vibrators, nor is it as costly as an electro-magnetic vibrator of equivalent capacity. This very-low-frequency vibration generator has a 2,000 lb thrust with a working range of 0-50 c/s and a maximum stroke of 4 in at the lowest frequencies. Both frequency and amplitude may be varied while the equipment is in use, remote control being from a power consol. A hydraulic jack is used by the vibrator unit to actuate an electrically-signalled valve; it is connected to the control unit/power pack by two high-pressure hydraulic lines and one electric control cable. No additional accessories are required in the way of amplifiers, oscillators, and output transformers, as the equipment is supplied complete. The vibrator itself weighs 1,100 lb and the control unit/power pack 600 lb. The power requirement is 4½ kW at 440V 3 phase + neutral 50 c/s ac.

Basically the equipment's ability to maintain a dynamic thrust of 2,000 lb over the full frequency range of 0-50 c/s means that it is capable of vibrating an item of this weight fixed to the table top and that it can also exert this load on an existing structure through appropriate linkage rods. Characteristic of the equipment's versatility is its ability to exert a static load without vibration. A static thrust of up to 10,000 lb is available. *Fairey Air Surveys Limited, 24 Bruton Street, London W1.*

HIGH-VACUUM PUMP

Continuous Operation



A NEW addition to the range of Mullard ultra high-vacuum devices is the VPP-5 Penning pump illustrated.

This pump, which is continuous in operation, is based on the principle of the Penning gauge, in which electrons are made to oscillate between cold cathodes. A magnetic field perpendicular to the direction of electron flow causes the electrons to traverse spiral paths as they oscillate in the electrostatic field formed by the cathodes and the anode. Ions produced by these electrons are accelerated to the cathodes and liberate more electrons, the combined action being self-supporting.

The unit comprises many Penning electrode units in parallel using common titanium cathodes on each side of a nest of anodes. During operation, the titanium sputters from the cathode on to the anodes, forming fresh surfaces which getter very actively. The life of the pump is dependent on the amount of titanium available at the cathode for sputtering. It is estimated that duration will be 10,000 hours at a pressure of 10^{-6} torr.

The pumping action of the VPP-5 will begin at a pressure of 5×10^{-2} torr and will continue until a pressure as low as 10^{-11} torr is reached. Over this range, the pumping speed for air is 5 litres per second. *Mullard Limited, Mullard House, Torrington Place, London WC1.*

INTERNATIONAL PACKAGING EXHIBITION

Olympia, London, 5-15 September

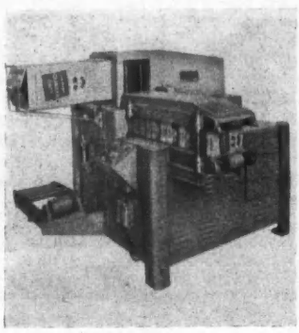
This exhibition, both in its size and importance, reflects the growth and development of packaging techniques. This year more than 300 firms are showing packaging materials, containers, machinery, and equipment. The area occupied is four times as great as that used for the first exhibition, which was held as recently as 1949. The international character and importance of the exhibition is illustrated by the increasing amount of foreign equipment which is displayed. German and Swiss products are particularly well represented, other overseas equipment includes that from France, Italy, Scandinavia, and America. Every aspect of packaging is covered.

Containers displayed include those manufactured from metal, glass, plastic, fibre, and for aerosol. Among the packaging materials are new reinforced papers and transparent films with high resistance to moisture, temperature variations, and acids. Also on show are new types of closure and drip-proof pouring devices. Ancillary equipment covers tape-sealing machines, automatic machinery for tensioning strapping, high-speed labelling machines, check-weighing equipment, converting machinery, printing machines, and electronic devices for detecting the presence of foreign bodies in foodstuffs.

Organization of the exhibition has been carried out by Provincial Exhibitors Limited and F. W. Bridges and Sons Limited, in collaboration with the Institute of Packaging. Some of the items on show are described on this page.

CASE-PACKING MACHINE

Automatic



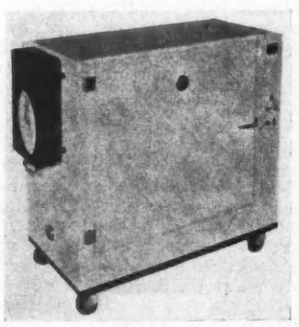
THE KANEpack case-packing machine which is electro-pneumatically operated, automatically packs square or rectangular packages at high speeds. It may be used in conjunction with fibreboard cartons and paper sacks.

It is claimed that the use of this packer will save money, and reduce labour, space, heavy work, and maintenance costs. Machines are built to suit individual requirements and several types are available. One machine may, within limits, be adjusted to meet different needs. The packages are fed from the filling or wrapping machines, to the intake conveyor. From there they are carried to the collating mechanism which assembles the complete predetermined pack. They are next pushed through a magazine into the preformed shipping case, as shown in the illustration. After filling the case is lowered to a conveyor.

All operations and movements are automatic, being initiated from either the individual packets or the shipping case. The motor-driven compressor unit is housed in the base of the machine and is fitted with a safety device which renders the machine inoperative in the event of a mishap. Packing arrangements, feed, presentation, and local conditions control the speed of operation; this can be up to 400 packets a minute. In the event of production necessitating the use of more than one machine, two or more machines may be collated to combine the outputs. *Frederick C. Kane Limited, Park Royal, London NW10.*

CLIMATIC CABINETS

Tests Under All Conditions



SHOWN here is the 337A model in the Weyco range of climatic cabinets, which, with requisite accessories, are designed to produce a wide variety of temperature and humidity conditions under continuous or cycling tests.

In this newly developed type of cabinet, accurate temperature control is provided by Weyco contact thermometers, and a positive air circulation is controlled in such a way that it remains unaffected by shelf or cabinet loading, each shelf receiving its correct proportion of conditioned air. The air conditioning itself takes place in a treatment chamber which surrounds the working chamber. Humidity is created by the injection of atomized water, and an advantage over steam injection methods is claimed in that high humidities are possible at low temperatures without affecting working temperature, and with accurate temperature and humidity control.

Additional features put forward are that this design enables faster drying on account of positive air circulation, and that the recovery time after opening the oven door is unusually quick. Humidity control is given as from 14 per cent to 100 per cent ± 1 per cent, and dry bulb ambient temperature can reach 60° C within ± 0·5° C. The temperature gradient throughout the working chamber is ± 1° C.

Various optional accessories are available. *Laboratory Equipment (London) Limited, Libra Works, 18-20 Dames Road, London E7.*

COLLAPSIBLE CONTAINERS

Reusable

THE Heston box-type aluminium container is a pallet to which sides and a lid may be securely attached in a matter of seconds.

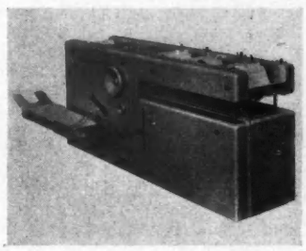
Hinge lips enable the sides to engage each other, these are then attached to the base and swung up into position. The top is next hinged to one of the sides and latched down. No tools are required for assembly. When the top is clipped down the container is completely fastened and no other method of securing is required. Provision can be made for locking as a security measure.

The weight of the contents, up to 3,500 lb, is taken by the four main supports. The base will withstand undistributed weights of up to 1,600 lb per sq. ft. Assembled, the size is 40 in wide, 48 in long, and 32 in high. The height collapsed is 8½ in.

The skid base, in addition to enabling handling by fork-lift truck, enables the container to be used on conveyor systems. Cleats at the top ensure that loaded containers may be securely stacked. Eyes are provided for handling by crane. The design allows the contents to be inspected by removing the top or any two sides. This may be done, even when the container is stacked without impairing its strength. Unloading is effected by removing six clips, when the sides may be taken off. The times required to assemble and dismantle the container are reported to be 30 seconds in each instance. *The Heston Group, Heston Airport, Hounslow, Middlesex.*

ENVELOPE-INSERTING MACHINE

Versatile Action



THE BANDAMAIL P5 inserting machine illustrated here is designed to handle a wide range of envelopes, and its function covers the operations of collating, inserting, sealing, counting and stacking.

Envelopes which can be handled include the open or closed window type, and the manufacturers stress that there are no restrictions regarding the variety of flap or gum, and claim that the unit is capable of operation for long runs at speeds that are up to 4,000 insertions per hour.

An unusual feature of the P5 is the extreme smallness of the lateral tolerances needed between the insert and the envelopes: the machine possesses a positive sealing action which is maintained irrespective of thickness of envelope.

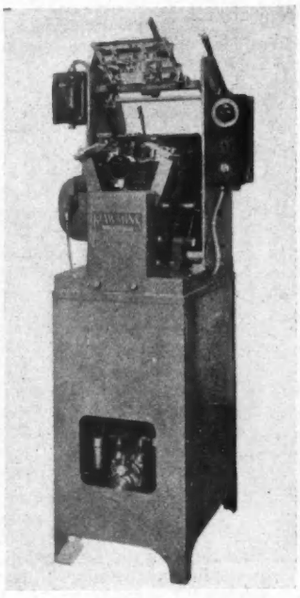
Each of eight stations is electrically controlled to ensure positive pick-up according to the thickness of the enclosure. In the event of a mis-feed, the machine stops and a flashing light identifies the station at which the stoppage has occurred.

Other interesting features of this high-speed machine include suction feed and the provision of a variable speed control. An electric counter is incorporated.

Envelope sizes which can be accommodated are 4 in maximum depth and 8 in maximum height, with minimum width at 4½ in and maximum width at 9½ in. The maximum thickness of envelopes which can be accepted is given as $\frac{3}{16}$ in. The construction and material are said to contribute to an expectation of trouble-free service. *Block and Anderson Limited, Banda House, Cambridge Grove, Hammersmith, London W6.*

LABELLING MACHINE

For Many Surfaces



DESIGNED for use with delayed-action Heatfix labels, this labeller, known as the Dry Precision machine, is said to possess unusually versatile qualities.

It permits labels to be applied (at speeds of up to 40 per minute) to many surfaces on to which ordinary machine gum will not adhere, as in the case of aluminium, polystyrene and cellulose acetate, for example.

The machine will apply panel or wing labels to flat, round and oval containers. It will also apply all-round labels to articles of square, round and oval sections. A special version is made for "flag" labelling.

The manufacturers claim that a longer working day is possible with this unit, as there is no loss of time for mixing gum or cleaning the machine: there is no shedding of labels under arctic or tropical conditions, and labelled goods can be packed straight from the machine. *Rawsons (Labelling Machines) Limited, North Farm Road, High Brooms, Tunbridge Wells, Kent.*

Road Surface Unaffected by the Weather

To prove the reserve drawbar pull of crawler tractors MEXE have built test tracks which are unaffected by temperature and rainfall. The surface is also easily repaired by rolling.

THERE has long been a need for realistic, comprehensive and unbiased means for judging the true performance abilities of construction and other similar plant. The manufacturer, given such a standard, has a basis for competitive claims for his machines that are valid and which mean something for the prospective purchaser. Facilities for such tests are now in use at the Military Engineering Experimental Establishment (MEXE) at Christchurch, Hampshire, and they include, in particular, a number of road surfaces which are used to test the reserve tractive ability of vehicles in any conditions of weather.

The work undertaken at MEXE to develop these road surfaces was described in a paper by the director, Sir Donald Bailey, O.B.E., presented at the annual meeting of the Society of Automotive Engineers at Detroit, USA, earlier this year. A measure of the success achieved is that damage to the road surface caused by grouser tear has been remedied by rolling; consistent measurements of tractive ability have been made under widely differing weather conditions; no difficulty has yet been experienced in obtaining sufficient adhesion to enable any tractor so far tested to be stalled; and at the end of four years of testing no reinstatement of the first surface layer had been required.

As a preliminary to laying test surfaces in a road, laboratory tests were used to find a sample composed of sand, clay and small chippings, and the optimum water content, that gave the highest shear strength. The most promising mix comprised

Clay	35 parts
Sand	50 parts
and ⅜ in Chippings	15 parts

Tests to procure the best moisture content showed that a water addition of 12 per cent appeared to offer the most all round advantages. The next step was to substitute a waterproofing binder for the water.

OBJECTIVES

Five road strips, each 39 ft by 15 ft, large enough for limited drawbar tests, were laid using the mix indicated above but with the binders and additives indicated below. The fifth strip, with water as the binder, acted as a comparator.

Strip	Binder	Additive
1	XRO 6 per cent	Nil
2	Rubberized bitumen 12 per cent	2½ per cent hydrated lime
3	XRO 8 per cent	Nil
4	Rubberized bitumen 14 per cent	2½ per cent hydrated lime
5	Water	Nil

A medium crawler tractor in a new condition was tested each month on all the strips until the control strip (the fifth, untreated) became unstable due to wet weather. Testing continued for 20 months on the remaining four strips so that data were obtained covering two summers and two winters, the same tractor and dynamometer car being used by the same test team throughout.

The results showed that the target had been straddled, for the highest binder content was liable to become plastic in midsummer and the lowest brittle in winter. The drawbar pulls measured on all of the bituminous surfaces were reasonably constant. The success of the preliminary experiment prompted the construction of a 15 ft wide lane 440 yards long. The objectives were:—

1. The provision of a test track for tracked vehicles that could provide sufficient adhesion for the full tractive effort of the machines to be developed and measured.
2. Tests should not be subject to temperature and other weather factors.
3. A track sufficiently plastic that marks made by the tested vehicle could be rolled out.
4. A track that would retain its characteristics for a long time.
5. A specification of the materials so that the track could be reproduced anywhere.

The track comprised a 2 in layer of hoggin gravel, well compacted, followed by a base course of bitumen macadam 2½ in thick. This macadam was covered by a thin (⅜ in) skin of fine asphalt to prevent ground moisture coming up into the working surface. The working surface of the track consisted of a 4 in layer of rubberized-bituminous-clay mixture of grit sand, ⅜ in to ¼ in crushed hard carboniferous limestone, and clay, all mixed with rubberized bitumen.

ACCEPTED MIXES

The rubberized bitumen was prepared as follows. A total of 2·7 per cent of a natural rubber powder was added to 200 penetration straight-run bitumen at a temperature of between 300° F and 320° F over a period of an hour and blending continued for about four hours; this increased the viscosity of the mixture to about 120/140 penetration. Approximately 20 per cent of creosote oils were added to the base and stirred for 30 minutes to reduce the base to the required viscosity of 25/35 seconds at 25° C; creosote oils were selected in preference to a petroleum oil because they contain an amount of phenolic material which assist the coating of the partially wet aggregates in the mix.

The specification of the course was as follows:—

Base course

	Per cent
1½ in nominal soft limestone	92·25
Filler (cyclone dust)	4·00
Rubberized bitumen	3·75

Fine asphalt

Grit sand	88·0
Filler, crushed limestone and cyclone dust in equal parts	7·0
Rubberized bitumen	5·0

Rubberized-bituminous-clay mixture

	Per cent		Per cent		Per cent
Clay-stone-sand mix	80	Clay	29		
		Sand and stone	71	Sand	75
				Stone	35
			100		100
Hydrated lime	2				
					Per cent
Rubberized bitumen	10	Rubber latex			2
		Creosote			20
		200 pen bitumen			78
	100				100

A special technique was developed for mixing the rubberized-bituminous-clay. After examination of the original experimental strips it was thought that the plasticity of the mixture was largely due to the preservation of the inherent moisture in the clay. The object was therefore to surround the clay nodules containing the desired percentage of moisture with stone and course grit sand to give mechanical strength, then intimately coat the mixture with bitumen to prevent the moisture leaving or reaching the clay. Rubber was added to increase the plasticity of the bitumen and to resist complete rupture of the bituminous membrane as the mixture is squeezed and deformed under the load of the tractor tracks. Where the particles are torn apart by the tractor grousers, it was thought that the rubber would assist the bitumen to heal.

A complete record was given in Sir Donald's paper of the method adopted for mixing the rubberized-bituminous-clay for the working surface. The clay was dug from a completely submerged pit and therefore contained a maximum natural moisture content; it was transported to the site as required and used immediately.

At the same time the grit sand and the crushed limestone (⅜ in to ¼ in) were dried and heated together to 180° F and mixed in a batch asphalt plant in the proportions of three parts grit to one of stone.

The dry stone-sand mixture was mixed with the wet clay in the following proportions:—

	lb	Per cent
Dry stone-sand mix	425	70·85
Wet clay	175	29·15

This mixing was carried out in a commercial pugmill after the materials had been proportioned in a weigh batcher. The clay, stone and sand mixture was discharged from the pugmill on to a conveyor belt and into a lorry. The large lumps of wet clay were thus shredded into small balls of up to 2 in diameter, with the sand and the stone mixture embedded in the surface of the clay.

A comparatively small quantity of water, 1 to 2 pints per 600 lb batch (0·4 to 0·8 per cent) added to a mix of low water content, was sufficient to give the desired result. This small amount did not affect the water content of the clay but it did serve to lubricate the particles of the aggregate and so enable mixing to proceed. The moisture content of the mix in the stockpile varied between 7·4 and 8·9 per cent.

The ultimate product was mixed in a conventional 90 ton per hour batch asphalt mixer. The clay, stone and sand mixture was fed into the feed hopper and passed through the drier and gently warmed to a temperature of between 110° F and 140° F. This dried the surface of the stone and sand embedded in the clay nodules but did not remove the whole of the moisture from the inside of the clay lumps. The warmed mixture was then passed over a 2⅜ in screen to reject the oversize lumps.

After weighing, the clay stone and sand mix was mixed for ½ minute, 2 per cent of hydrated lime added and mixing continued for another minute. The rubberized bitumen, between 9 and 10 per cent by weight, and at a temperature of 180° F, was poured over the material and the mixing continued for a further two minutes until the whole was thoroughly coated. The batches were limited to half the normal capacity of the mixing mill because of the severe load on the plant; even so, strengthened shear pins had to be used in the drives to ensure against damage due to overloading.

The moisture content of the rubberized-bituminous-clay mixture coming from the mixer varied between 0·45 per cent and 3·2 per cent as compared with the 2½ per cent aimed for.

LAYING THE SURFACE

Both the base course and the fine asphalt were laid by a 7 ft commercial layer in the normal way and no difficulties were encountered. Attempts were made to use the same machine to lay the rubberized-bituminous-clay in two lanes but the material proved to be so difficult to handle that a heavier 10 ft machine with extension pieces to lay a 12 ft lane was employed. Hand work was necessary to fill in depressions or where the material had dragged. Immediately laying was complete, the surface was rolled with a six ton tandem roller.

When the track was first laid, it was soft and yielded to the weight of a man standing upon it but after a month the surface had hardened sufficiently for use. With constant use and aging, the condition of the track is expected to deteriorate because the loss of the more volatile oils in the bitumen will cause a hardening of the bitumen, especially in the top surface; and the continual shearing of the clay nodules, thereby exposing their faces to the air, will allow the moisture in the clay to be lost.

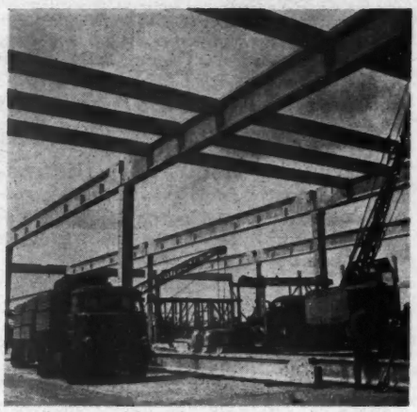
Following the successful construction and use of this test track a second was built, though twice as wide. This overcame the difficulty met in the narrow 15 ft track that wear tended to be concentrated in two positions, displacing the plastic materials towards the centre and sides of the track. Recently another track, in the form of a figure of eight and with an adjacent surface for wheeled vehicles, has been laid to accommodate tractors developing drawbar pulls of 80,000 lb.

New Warehouse at Amsterdam

A new dock warehouse, 1,190 ft long and 200 ft wide, at Amsterdam is nearing completion and goods are already being stored in a finished section of the work. Work on the site commenced in January this year and the erection of the framing began in April. The work will be completed in October.

The structure is composed of precast, reinforced concrete columns 25 ft long carried on precast concrete raking piles driven to refusal. Columns are spaced at 70 ft intervals along its length at 40 ft centres across its width. *In situ* column footings with projecting reinforcement were cast above the piles and grouted into holes at the bottom of the columns.

The main beams span the 70 ft longitudinally between columns. Each beam weighs 17 tons and is composed of precast concrete segments, post-tensioned together and lifted into position. Spanning across the building transversely between the main beams are precast pre-tensioned secondary beams. These secondary beams are generally at 8 ft 9 in centres, but where roof glazing is provided a secondary beam is omitted to make the spacing 17 ft 6 in. Around the outside of the building precast perimeter beams span between columns. The roofing is of precast lightweight concrete units covered by roofing felt. The infilling for the walls is of brick and the floor is made of concrete.



Concrete framing for dock warehouse.

Port Development in West Africa

Construction has begun at the free port of Monrovia in Liberia, West Africa, on a further major improvement—a new ore-loading pier—designed to meet the needs of Liberia's fast growing economic expansion and growing exports of iron ore, rubber, latex and palm kernels.

The new facility, an 855 ft long finger pier, will be utilized by Liberia Mining Company for shipping to world steel markets high-grade iron ore dug from extensive deposits in the Bomi Hills mines just 43 miles inland. The contract for the construction of the pier—and also for 12 dolphins—has been let to Raymond International Liberia Limited; the work is valued at £500,000 and is scheduled for completion in January 1962.

The port consists of a triangular-shaped artificial harbour, formed by two long breakwaters extending over a mile into the open sea, and providing 750 acres of protected water. Dredging operations carried out during the past 12 months, and recently completed, have increased the depth of the port's turning basin from 30 to 35 ft.

The pier will accommodate vessels of 35 ft draft. There will be a maximum loading capacity of approximately 2,500 long tons of natural fines and concentrates per hour, or 1,690 long tons of lump per hour. Loading will be carried out from either side of the pier and will greatly speed up shipment operations now done from the existing Liberia Mining Company wharf.

By shifting the ore-loading operations to the new pier, 850 ft of wharf space will be freed for servicing dry cargo vessels. This section of the port will then be able to accommodate two additional medium size cargo vessels, or three smaller ones, and bring the total wharf length to 2,000 ft overall.

The pier will be equipped with a loading tower which moves along a track to line up opposite the holds of the ore vessels to be loaded. A two mile long endless belt will run from the tower back to the ore discharging facilities on shore where railroad cars will dump their loads directly on to the belt.

On either side of the new pier there will be six dolphins, each comprising clusters of steel piles, sunk vertically into the harbour bed to hold vessels several feet off the quay during loading. Piling for the pier will be of all steel, cathodic-protected to prevent corrosion.

Another ore pier, now under construction for National Iron Ore Company Limited, is nearing completion just as the company's Mano River ore deposits are expected to come into production. A third new port facility is a petroleum pier that is being built some 1,600 ft from the southerly breakwater of the port. This new pier, scheduled to be completed by later November of this year, will accommodate tankers, also of 35 ft. draught.

The present cargo wharf of some 1,150 ft in length, can berth three vessels of the Liberty class or four smaller ones including coastal and feeder craft. Shoreside operations of the port encompass more than 705 acres, and this area is being enlarged by fill from dredging operations. In addition to work already mentioned, the port authority is also undertaking other cargo handling improvements. For the year 1961, orders worth nearly £100,000 for cargo have been placed for moving equipment, including heavy-lift cranes. Iron ore exports alone are expected to exceed 3,000,000 tons during 1961 and the Government estimates that iron ore shipments out of the port will reach 10 to 15 million tons a year by 1965.

Tube Piles Made in Cast Steel

The main cooling water intake structure at the Dungeness Nuclear Power Station is 1,000 ft offshore and will rely for anchorage on 12 cast steel tube piles supplied by Head Wrightson Steel Foundries Limited, a subsidiary of Head Wrightson and Company Limited.

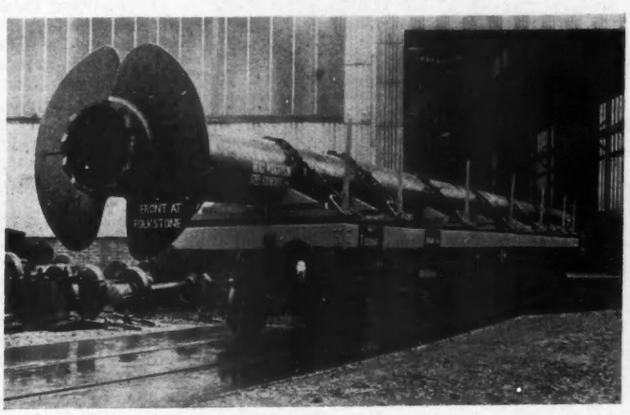
The tubes, which measure 80 ft in length and 30 in diameter, are believed to be the first of their kind to be made up as castings. Cast horizontally in high tensile steel (material to BSS 392 : 1937, grade "C") in 10 ft lengths, the tubes were tapered one thickness into another to reduce the overall weight and the sections welded together. By using this method of construction it was possible to use a higher tensile steel, with the additional advantage over prefabricated tubes of reduced weight and shorter delivery.

Each cast steel pile is fitted with a 4 ft long screw, 6 ft in diameter, to form a leg of the 1,100 ton octagonal working platform, which measures some 90 ft across and 75 ft from base to deck level. The cast steel tube piles are contained in outer tubular casings which form an integral part of the structure.

Excavation for the hollow piles will be carried out by means of an air lift pump, and deck mounted pile screwing gear will drive the cast tube piles to a depth of about 50 ft. Each tube pile will then be filled with reinforced concrete.

Flotation tanks, controlled by hydraulic jacks, maintain bouyancy of the structure during screwing operations. Cathodic protection apparatus has been fitted to combat corrosion and other forms of deterioration resulting from permanent submersion in sea water.

Sir Robert McAlpine and Sons are responsible for the design and subsequent removal by sea to Dungeness and erection. Both Head Wrightson and Sir Robert McAlpine and Sons are members of the Nuclear Power Group, Knutsford, Cheshire, the principal contractors for the Dungeness Power Station.



80 ft long cast steel tube pile, complete with screw, leaving the maker's works en route for Dungeness nuclear power station.

Starting Large Synchronous Condensers

A purely electrical method has been developed for the automatic starting of large generators used as synchronous condensers. Power requirements are very small—about 1·2 per cent of the generator rating.

By N. Young, A.M.I.E.E., and A. Gray, B.Sc., A.M.I.E.E.

C. A. Parsons and Company Limited

IN MANY of the hydroelectric systems throughout the world, it is necessary to provide steam-driven plant for use in times of water shortage. As the hydro plant is usually sited in mountainous areas, it is often many miles from the load centre. The steam plant can be, and usually is, much nearer the load centre. In these circumstances, when the hydro plant is developing full output the generators on the steam plant can be put to good use as synchronous condensers, improving the voltage control and stability of the system. Similar circumstances arise in systems using modern high merit base load steam plant situated on coalfields or in remote nuclear power stations. In this case, the older, less efficient plant is held in reserve for peak loading, and during times of light load on the system can be used as synchronous condensers.

A recent paper by Powell, Mutch, Stalewski and Toms describes a method of using turbo-generators as synchronous condensers in which the turbine is left coupled to the generator[1]. The method requires vacuum to be established at the turbine exhaust, and a small steam flow to be maintained to remove heat generated in windage loss in the turbine blades. In the interests of economy, however, and to enable maintenance to be carried out it is desirable to shut down the boilers and turbines.

STARTING UNCOUPLED GENERATORS

There are a number of solutions to the problem of starting generators that have been uncoupled from the turbine. In one method the generator is provided with an oversize shaft driven exciter which is used as a dc starting motor, obtaining its supply from a motor driven dc generator. An alternative is to use a slip ring induction motor coupled to the generator through a gear box, with the gear ratio chosen so that synchronism with the system can be achieved.

Reduced Voltage Method

Where neither of these mechanical methods is applicable, generators have been started by switching on to the line at reduced voltage (to avoid the surge resulting from direct switching). Although the method is used mainly for multipolar machines, it has been applied successfully to a number of two pole machines.

At the R. L. Hearn generating station of the Ontario Hydro, there are four 100 MW and four 200 MW sets. Provision has been made to run these as synchronous condensers when not being used as generators.

Variable Frequency Supply

Papers by Holdup and Dickson describe a method of starting generators electrically, by supplying the stator with power at variable frequency obtained from a spare steam driven turbo generator[2, 3, 4].

This scheme has the disadvantage that the variable frequency generator must have a rating of at least 30 per cent of that of the condenser. In addition, a boiler must be commissioned and must be available to restart the synchronous condenser in the event of a momentary supply failure causing it to trip out, and sections of the station HV bus-bars must be isolated from the system to carry the variable frequency supply.

Synchronous Starting

A purely electrical starting method[5] in which the power is taken from the system has obvious advantages, and such a scheme has been developed and manufactured for Unit 6 at the R.L. Hearn Generating Station of the Ontario Hydro in Canada.

In this scheme, power is taken from the system through the station service transformer to a motor generator set. This consists of a ten-pole slip-ring induction motor rated at 3,300 hp at 600 rpm driving a twelve-pole variable-frequency generator rated at 2,400 kW, 0·8 PF. The supply to the motor is at 60 c/s, and since the generator has an extra pair of poles its frequency range extends beyond 60 c/s.

The smaller machine is quite incapable of supplying the magnetizing kVA for the synchronous condenser and its main and auxiliary transformers, and at the same time developing the torque required to break the condenser away from rest. The essence of the scheme is that the turning gear is fitted on the generator side of the turbine-generator coupling, and with the coupling bolts removed, the condenser is started from rest through this gear. With the condenser turning, magnetization can be supplied to the rotor in the normal manner. The condenser, acting as a very low frequency generator, can then be used to start the smaller machine, and when this in turn is excited the two will lock in synchronism. The MG set motor is then energized and used to accelerate the combination up to synchronism with the system, and the main circuit breaker is closed. The MG set is then tripped off the line and is available to start other synchronous condensers—a further advantage of the scheme.

In the R.L. Hearn station there are four 100 MW units (1 to 4) and four 200 MW cross compound units (5 to 8). This is, incidentally, the largest power station in the world containing turbo-generators all of the same manufacture. The starting equipment is designed to start both generators of unit 6 simultaneously, and provision is made to extend the scope to units 7 and 8. Selection of the unit to be started is by a plug and socket arrangement in the automatic control circuits.

The two generators of units 6, 7 and 8 are solidly coupled together on the generator side of the main transformers, each unit being controlled by only one circuit breaker. The two generators of a unit run at different speeds, the "high pressure" line running at 3,600 rpm and the "low pressure" line at 1,800 rpm. Motor driven exciters are used, and these provide the necessary excitation at low speeds. If the exciters had been shaft driven it would have been necessary to make use of an alternative dc supply for this purpose. This could be a small motor driven generator or a transformer-rectifier set, rated at about 20 per cent of that of the main exciter.

AUTOMATIC CONTROL EQUIPMENT

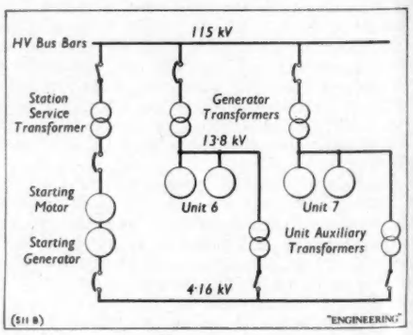
One of the difficulties in operating synchronous condensers on a system is that in the event of a system disturbance causing a serious failure of supply, the synchronous condensers will fall out of synchronism with the system causing serious overcurrents, and the machine protection must therefore be arranged to trip the breaker. The problem then is to reconnect the synchronous condenser in the minimum time, to assist in restoring stability to the system. To this end, the starting equipment has been made completely automatic in operation.

There are some 20 operations to be carried out on starting the synchronous condenser and these must occur in a logical sequence. The control equipment has, therefore, been designed to carry out the individual operations as discrete steps with the initiation of one step depending on the successful completion of all the appropriate previous ones. The sequence of events is illustrated in the flow diagram.

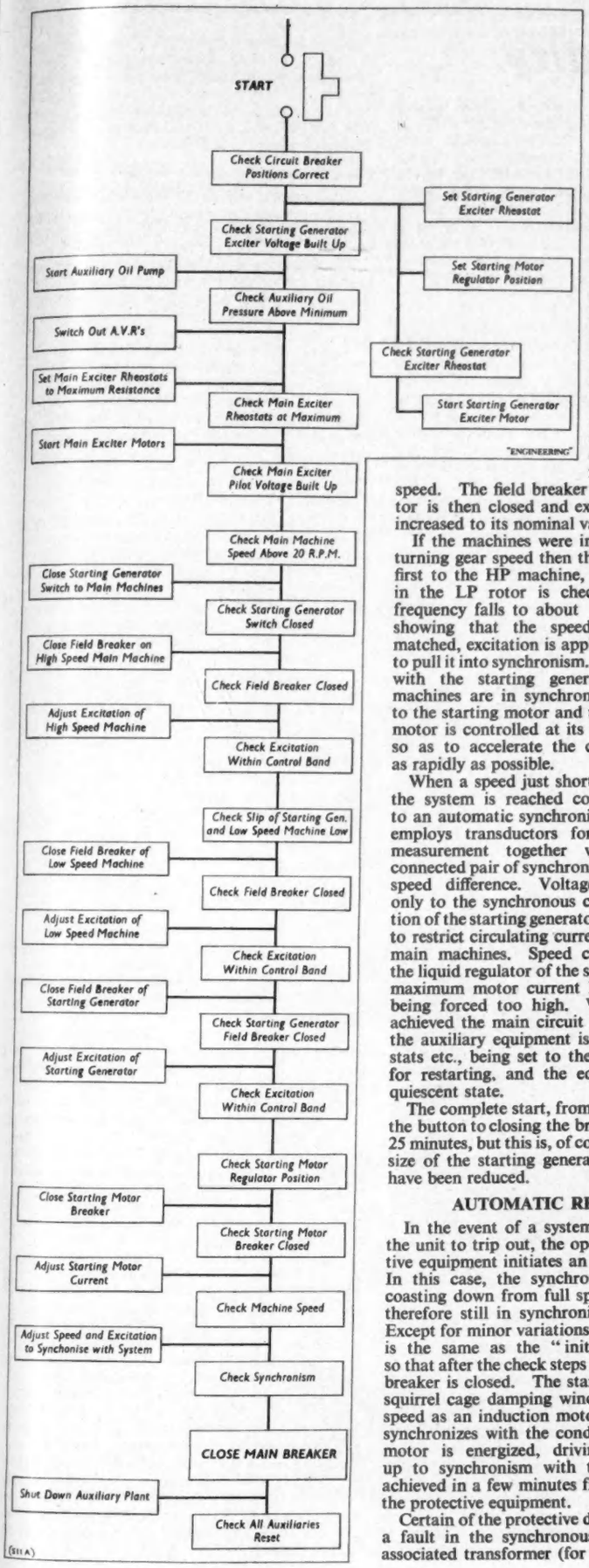
As the system has been designed for fully automatic control, emphasis is placed on reliability and fail to safety features, the various operations being checked by circuits independent of the one initiating the operation, a positive check being obtained, and subsequently maintained, before passing on to the next step. If at any time subsequent to the successful completion of an operation the check signal vanishes, then the sequence as a whole is halted until the signal reappears. In addition, for certain failures which give rise to fault conditions the plant is simultaneously tripped. Sequencing and control is carried out by heavy duty relays operating from the 125 volt station battery.

Briefly, the main sequence of events during an initial start is as follows:

Before a start signal is accepted the protection relays of the synchronous condenser are inspected via auxiliary contacts to see if a fault condition exists, and if not the sequence is initiated. The first step in the sequence is an inspection of all the circuit breakers associated with the plant to check that they are in the appropriate position. After this the exciter rheostats and motor speed regulator are set to their correct position for starting, and checked; their normal quiescent position is such as to enable the motor to "pick up" the synchronous condenser running at high speed with the least possible delay. The exciter motors and lubricating oil pump are started and checked (using exciter voltage and oil pressure



Line diagram of connections at the R. L. Hearn station.


START
Check Circuit Breaker Positions Correct
Set Starting Generator Exciter Rheostat
Check Starting Generator Exciter Voltage Built Up
Start Auxiliary Oil Pump
Set Starting Motor Regulator Position
Check Auxiliary Oil Pressure Above Minimum
Switch Out A.V.R's
Check Starting Generator Exciter Rheostat
Set Main Exciter Rheostats to Maximum Resistance
Check Main Exciter Rheostats at Maximum
Start Starting Generator Exciter Motor
Start Main Exciter Motors
"ENGINEERING"
Check Main Exciter Pilot Voltage Built Up
Check Main Machine Speed Above 20 R.P.M.
Close Starting Generator Switch to Main Machines
Check Starting Generator Switch Closed
Close Field Breaker on High Speed Main Machine
Check Field Breaker Closed
Adjust Excitation of High Speed Machine
Check Excitation Within Control Band
Check Slip of Starting Gen. and Low Speed Machine Low
Close Field Breaker of Low Speed Machine
Check Field Breaker Closed
Adjust Excitation of Low Speed Machine
Check Excitation Within Control Band
Close Field Breaker of Starting Generator
Check Starting Generator Field Breaker Closed
Adjust Excitation of Starting Generator
Check Excitation Within Control Band
Check Starting Motor Regulator Position
Close Starting Motor Breaker
Check Starting Motor Breaker Closed
Adjust Starting Motor Current
Check Machine Speed
Adjust Speed and Excitation to Synchonise with System
Check Synchronism
CLOSE MAIN BREAKER
Shut Down Auxiliary Plant
Check All Auxiliaries Reset
(511A)

Sequence of operations for the automatic starting of the generators when used as synchronous condensers.

as checks) and the speed of the main machines checked as being at turning gear speed or higher, using a tachometer and magnetic amplifier. The breaker connecting the starting generator to the synchronous condenser is closed and the excitation is applied to the condenser pair and increased to and controlled at the value corresponding to normal volts at normal speed. The field breaker of the starting generator is then closed and excitation is applied and increased to its nominal value.

If the machines were initially at greater than turning gear speed then the excitation is applied first to the HP machine, and the slip frequency in the LP rotor is checked. When the slip frequency falls to about one cycle per second, showing that the speeds are approximately matched, excitation is applied to the LP machine to pull it into synchronism. This is then repeated with the starting generator. When all the machines are in synchronism power is applied to the starting motor and the line current of this motor is controlled at its rated maximum value so as to accelerate the combination to speed as rapidly as possible.

When a speed just short of synchronous with the system is reached control is handed over to an automatic synchronizing equipment which employs transductors for voltage and phase measurement together with a differentially connected pair of synchronous motors to measure speed difference. Voltage control is applied only to the synchronous condensers, the excitation of the starting generator now being controlled to restrict circulating current between it and the main machines. Speed control is applied via the liquid regulator of the starting motor with the maximum motor current limited to prevent its being forced too high. When synchronism is achieved the main circuit breaker is closed and the auxiliary equipment is shut down, all rheostats etc., being set to the position appropriate for restarting, and the equipment is left in a quiescent state.

The complete start, from initiation by pressing the button to closing the breaker, occupies about 25 minutes, but this is, of course, a function of the size of the starting generator, and could easily have been reduced.

AUTOMATIC RESTARTING

In the event of a system disturbance causing the unit to trip out, the operation of the protective equipment initiates an "automatic restart." In this case, the synchronous condensers are coasting down from full speed, still excited and therefore still in synchronism with each other. Except for minor variations the starting sequence is the same as the "initial start" sequence, so that after the check steps the starting generator breaker is closed. The starting generator has a squirrel cage damping winding, and runs up to speed as an induction motor. It is excited and synchronizes with the condensers, and again its motor is energized, driving the combination up to synchronism with the system. This is achieved in a few minutes from the operation of the protective equipment.

Certain of the protective devices which indicate a fault in the synchronous condensers or the associated transformer (for example, differential protection or transformer Buchholtz protection) are arranged to lock-out the automatic restart feature. In the event of a restart having been initiated by operation of the bus-bar overcurrent protection, subsequent operation of these devices will cancel the restart and trip all the breakers associated with the sequence. Manual intervention is then necessary before the synchronous condensers can be restarted. In addition, there are push buttons to hold the sequence at any point, to cancel the "hold" signal, and to initiate emergency tripping of all the breakers, thus shutting down the synchronous condensers and all the starting equipment. There is a further push button labelled "Permit synchronization" which must be pressed before the automatic control equipment can complete the starting sequence by closing the main breaker. The purpose of this button is to ensure that the decision to synchronize is always made by the operator, and not by the unattended automatic starting equipment.

Future Installation

The R. L. Hearn generating station is operated in two sections, with the four 100 MW units connected to one section and the four 200 MW units to the other. The sections feed different lines out of the station, and it is convenient to operate these independently. During the summer months it is desirable to have synchronous condensers connected to both sections, and a second starting equipment capable of starting any of the eight units has been discussed. The second equipment would be similar to the first, and the two would be arranged so that any two of units 6, 7 and 8 could be started concurrently. In addition, however, the second equipment could be used on unit 5, or by reducing the generator excitation to match the reduced voltage of the unit auxiliary bus-bars, on any one of units 1 to 4.

There would be several developments in the control equipment, aimed at reducing the time required to restart a unit tripped out due to a system disturbance. Perhaps the major improvement would be secured by replacing the manual selection plugs by an automatic selection device.

In the first equipment (which is planned to start any one of units 6, 7 and 8) if more than one unit is running as a synchronous condenser, the restart facility is available only to the unit which is selected. The other units can, of course, be restarted by changing the selector plugs and operating the push button.

In the second equipment, an automatic unit selection device will detect a trip out of any running unit, select it by means of a solenoid operated battery of small switches, and restart it. In the event of more than one unit tripping simultaneously, a priority order will be maintained, and the units restarted consecutively. The first equipment will restart the selected unit of 6, 7 or 8 concurrently with this.

Acknowledgements

The authors wish to thank the directors of C. A. Parsons and Company Limited for permission to publish this paper; Ontario Hydro for the photograph; both Ontario Hydro and the Stone and Webster Engineering Corporation for information used in the paper's preparation, and their colleagues for assistance.

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Imminent Criticality

LAST week fuel loading began in the No. 1 reactors at Berkeley and Bradwell and initial criticality is expected to be reached in the very near future. At Berkeley approximately 660 channels out of a total of 3,275 will be filled with about 50 tonnes of uranium fuel. The complete load of 232 tonnes required to bring the reactor fully operational should be accomplished by the beginning of next year depending on the time that preliminary tests and measurements take. Due to the number of channels being less in the Bradwell reactor the fuel loading will be shorter, but a similar number of tests will have to be undertaken, and full power operation is not expected until early next year.

Longer Working Hours for BEPO

Under the present arrangements, the Harwell test reactor BEPO operates at continuous full-power operation during the week—shutting down every Monday. From both an operating and experimental aspect, it would be more desirable and economical to have longer running times between shut-down periods. It has not been possible to lengthen the period of continuous operation, due to loading and unloading of the larger isotope sources, since these isotopes must be provided at intervals not exceeding one week. This serious limitation has not been overcome until recently with the design and construction of equipment which will load and unload from the vertical TE holes in the reactor while running at full power. The apparatus will also load the isotopes into individual pots ready to be taken to the Radiochemical Centre, Amersham, or alternatively the isotopes may temporarily be placed in two storage holes in the reactor area.

There are several advantages from the increased running periods: isotopes will be available when required, instead of once a week as at present. This will give an estimated average increase in yield of 20 per cent with the short lived isotopes. The number of burst fuel elements should be reduced due to the reduction of temperature cycling occurring at each shut-down. It will be possible to have longer periods of uninterrupted irradiation.

The equipment may be divided into three main parts: the in-pile section, consisting of aluminium liner tubes for the holes and shield plugs; the reactor load and unload unit for placing the isotopes into or removing them from the reactor; and finally the unloading stand. ("The BEPO TE Hole Isotope Load/Unload Flask," by A. Emmerton.)

Critical Control

The conference organized by the OEEC at Karlsruhe Nuclear Research Centre recently showed that out of the three basic principles in criticality control—by the control of mass, of concentration, or the geometry of the fissile material—there seemed general agreement that the latter was the most important, and was the main consideration in the current practical designs. This was particularly true of the most recent processes where the tendency was to replace batch treatment by continuous treatment. It was found as a result of the conference that France had carried out most of her work by theoretical studies, whereas the United States and the United Kingdom had more practical knowledge. But whatever the basic approach, the lack of precise knowledge over some parameters had compelled the use of large safety factors. New information was given on criticality of the higher isotopes of plutonium, especially plutonium 240.

First Contract for Spent Fuel

The USAEC has signed its first contract making financial arrangements for the processing of irradiated reactor fuel returned from a licensed firm. Fuel elements used in the original core of the General Electric Company Vallecitos Boiling Water Reactor will be accepted by the AEC at the National Reactor Testing Station, near Idaho Falls. The fuel elements were highly enriched in uranium 235, and after use in the reactor still contain enough unburned fissionable material to make chemical recovery economically desirable. The unburned uranium 235 is worth about $500 per ounce. The used fuel elements may not be processed immediately, but a financial settlement will be made with the company.

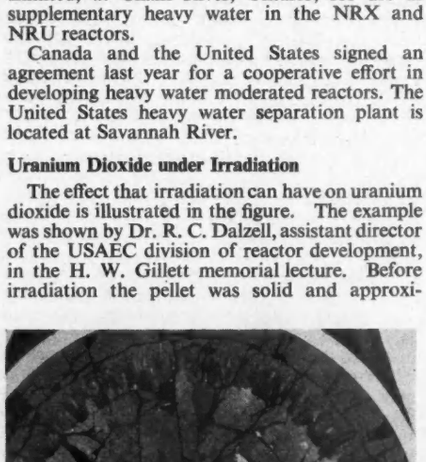
Record Sales of Heavy Water

The sale of 169,500 pounds of heavy water to the Government of Canada, the largest shipment made by the United States since it commenced the sale of heavy water to foreign countries in 1955, resulted in a record quarter year total of 170,625 pounds for the period ending 31 March, 1961. The combined sales, including 1,000 pounds to Norway and 125 pounds to Australia, at the established price of $28 per pound, amounted to $4,777,500. Canada purchased the heavy water at a cost of $4,746,000 for use in its natural uranium fuelled, heavy water moderated, power reactor programme. Most of the shipment, 159,500 pounds, will be employed in the 20,000 kW(e) prototype NPD-2 power demonstration reactor which is nearing completion. The other 10,000 pounds were sent to the Atomic Energy of Canada Limited, at Chalk River, Ontario, for use as supplementary heavy water in the NRX and NRU reactors.

Canada and the United States signed an agreement last year for a cooperative effort in developing heavy water moderated reactors. The United States heavy water separation plant is located at Savannah River.

Uranium Dioxide under Irradiation

The effect that irradiation can have on uranium dioxide is illustrated in the figure. The example was shown by Dr. R. C. Dalzell, assistant director of the USAEC division of reactor development, in the H. W. Gillett memorial lecture. Before irradiation the pellet was solid and approximately 93 per cent theoretical density. It was operated at a central temperature below the melting point of uranium dioxide. After irradiation the density was no longer uniform, and uranium dioxide has an appreciable vapour pressure below its melting point. The pressure, coupled with hole diffusion, in effect has transferred some of the diffused porosity to a central cavity. The circumferential cracks not only show a change in density but act as a barrier to heat flow. The uranium dioxide crystalline structure is relied on to retain a substantial part of the fission gases, but if the sublimation is a progressive action these gases will produce more pressure in the capsule than expected. This build up can only be eliminated by either starting with 100 per cent theoretical density or designing for high pressure containment.



Effect of irradiation on a sintered uranium dioxide fuel element.

Glass Contains Radioactive Wastes

Experimental work has shown that the properties of a specially prepared type of glass remain substantially unchanged when samples are subjected to radiation doses of 10^{11} rads.

The glass developed by the chemical engineering division of the UKAEA at Harwell is produced by making a slurry of silica and borax in a nitric acid solution of the concentrated liquid wastes. When evaporated to red heat, it sinters and melts and on cooling solidifies to a glass of the chosen composition. A typical product might contain 20 to 30 per cent, by weight, of waste oxides. The design of a pilot plant to handle 1,000 curies of active waste per batch has now reached an advanced stage, and the new unit will provide data for a full-scale plant.

Thermionic Conversion Device

A thermionic conversion device that may greatly increase the overall efficiency of nuclear power stations is being tested by the United States General Electric Company. The plasma diode is a high-temperature thermionic converter using caesium gas and a uranium-bearing cathode. These diodes could be built into nuclear fuel elements, where the fissioning of the uranium in the cathode would provide the high temperatures (about 4,500° F) needed for efficient direct conversion. An electrical lead from the fuel element would draw off the electricity, and heat rejected by the device would be converted into electricity by the standard thermodynamic cycle.

Developmental diodes are now being made at Vallecitos Atomic Laboratory. Single-cell devices able to generate several watts are now being tested, and thermionic conversion devices capable of producing approximately 20 watts per sq. cm of cathode area have been demonstrated. However, much more development will be necessary before they will be suitable for general application.

Reactor Notes

Space Vehicles: The USAEC has authorized the construction of a 100 kW(t) TRIGA mark 7 pulsing reactor for investigation of radiation effects upon systems and components used in space vehicles.

Process Steam Reactor Project: Four organizations have indicated their interest in participating in a demonstration low temperature process steam project incorporating a nuclear reactor. The nuclear portion of the plant will have an indirect cycle nuclear steam supply system with a plant output of 30 to 40 MW(t) at steam pressures ranging from 15 to 200 lb per sq. in. The plant is scheduled for completion in the winter of 1964-65. This type of system is designed for industrial operations requiring large amounts of heat—for example, distillation and chemical processing plants.

Another BWR: A 350 MW boiling water reactor is to be built at Bodega Bay, California, by the Pacific Gas and Electric Company. It is the largest single cycle boiling water reactor built so far in the States. The average life of the core, containing 175,000 lb of uranium dioxide, will be 3½ years. The method of containment is by pressure suppression, where the reactor vessel is enclosed in a "dry well" directly connected to a pool of water or a heat sink. In the event of a failure or rupture in the reactor pressure vessel system, heat from the escaping steam and water would be absorbed in the pool; this eliminates the containment sphere. The construction of the plant will begin in April, 1962, with completion scheduled for late 1965, and the cost will be approximately £21·1 million.

Companies

Modern Firms Want Modern Offices

CONSTRUCTION work on the building of new offices is proceeding apace in almost all the business sections of the London area: in the City, in the West End and in the outskirts; and the same pattern is the rule in many of Britain's big towns.

Demands for new office accommodation seems nearly inexhaustible and are due partly, of course, to the fact that it is mostly cheaper to start afresh in a new building than to try to adapt an existing old-fashioned structure to modern needs.

Among firms who have recently opened new premises in London are the GUEST, KEEN AND NETTLEFOLDS group of companies, G. A. HARVEY AND COMPANY (LONDON) LIMITED and C. A. PARSONS AND COMPANY LIMITED.

In the case of Parsons, the move from 56 Victoria Street to premises of double the extent at 40 Broadway, London SW1, is complementary to important developments at the firm's works in Newcastle upon Tyne, where a large nuclear research station and mechanical engineering laboratory have been erected. These installations represent the latest achievements in the firm's research techniques and are all part of what may be called "Parsons Progress."

Parallel with this work in Newcastle has been the necessity for expanding their London offices, which cover many activities, including technical sales representation for many of the company's larger products: turbo-generators, condensing plant, transformers, steel fabrications and gas turbines.

The need for liaison with the Central Electricity Generating Board, consulting engineers and overseas customers has also been a major consideration. The London office also provides a maintenance service in the area.

Glass by the Acre

GKN House, the new seven-storey office block of the Guest, Keen and Nettlefolds group, occupies a central position between the City and the West End. It provides accommodation for 500 employees and the amenities include two basements for car parking.

Until last year, the London address for the group was in Cannon Street, in the City, but only a relatively small number of the companies composing the group could be housed there and the other units had their offices in many different parts of London.

The new offices bring together in one building the London staffs of all the group's subsidiaries and thus fulfil the wish of the GKN directors to have a central home, where the needs of the group and their customers in this country and overseas could be served with the maximum efficiency. Greater amenities and better working conditions for their staff were other major considerations.

Glass is a conspicuous feature throughout the building, externally as well as internally. This material, in fact, plays a prominent part in the office blocks of all three firms. The GKN building, an exterior view of which is shown in the lower of the two illustrations on this page, is constructed on a reinforced-concrete frame with external curtain walling, which comprises no fewer than 31,000 sq. ft of glass. The end elevations of the building are clad in Portland stone.

While internally the structure presents a carefully harmonized whole, a number of definitely individual decors have been created, suited to the special characters of the group's various constituents. As already stated, glass is used extensively, especially in dividing walls and partitions, with the result that a sense of light and spaciousness exists everywhere.

Customers' Needs the Main Concern

As is the case with Parsons and Harvey, sales are a principal concern at GKN House. It is pleasing, on a visit, to see each constituent firm quietly getting on with their own jobs without undue display.

Thus, in the showrooms, there is a modest notice against Garringtons's exhibit of drop forgings stating that this member company makes 100 million drop forgings every year. This total, however, reputedly represents some four-fifths of all drop forgings produced in Britain.

One of the floors is devoted to firms supplying the requirements of civil engineering customers and the amount of space given to one of them, GKN REINFORCEMENTS LIMITED, is noteworthy. A drawing office accommodating 70 persons indicates the value which the group places upon having designers and detailers on the spot when dealing with the needs of architects and builders.

To select at random a few items for special mention, the main structural flooring consists of prestressed planks with hollow pots, finished with Missanda hardwood. Ceilings consist mainly of Petradene acoustic plaster tiles. Corridor wall lighting was designed by the GENERAL ELECTRIC COMPANY LIMITED. Electrical fittings were designed by ASSOCIATED ELECTRICAL INDUSTRIES LIMITED.

Actually, the GKN group have called upon the products of many of their own member-firms in the construction and furnishing of their building. For instance, all but a few of the offices contain metal furniture supplied by SANKEY-SHELDON LIMITED, a member of the group.

Through Nine Decades

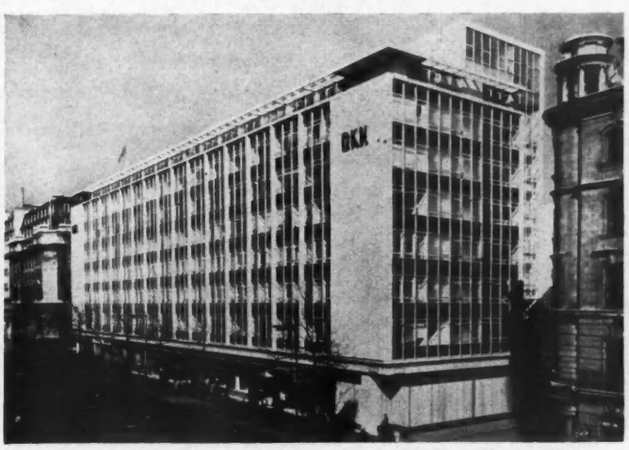
Harvey's, with their wide variety of specialized products, have developed out of a one-man business started by George Alfred Harvey in 1874, on the completion of his apprenticeship as a zinc worker.

The firm's new head sales office and showrooms are situated on the first floor of Villiers House, a recently-constructed office block next door to London's Charing Cross railway station. The extensive use made of glass in these offices is apparent from the upper of the two illustrations on this page and is another instance of how the increasing employment of this material is providing improved working conditions.

In the showrooms are exhibited examples of the Harvey and Harvey-Milner ranges of steel office furniture and partitioning. Attention is also directed to the work of some of the company's other departments: heavy fabrication, light fabrication, sheet metalwork, wirework, weaving and galvanizing.

Six provincial offices and showrooms have recently been opened by the firm—three of them in July—at Birmingham, Bristol, Glasgow, Leeds, Liverpool and Manchester. They are similar in style, each is situated in a modern office block and has a floor area of about 1,200 sq. ft. All six are linked with Villiers House and with the firm's works at Greenwich by the Telex communication system.

An interior at the offices of G. A. Harvey, showing accommodation for sales representatives and, in the background, the office of the London branch manager. An example of the increasing internal use of glass.



A London office exterior. GKN House, Kingsway, on the site of the old Stoll Theatre. The curtain walling alone contains 31,000 sq. ft of glass.

Financing Engineering Projects

Additional difficulties in connection with providing engineering finance, caused by Government action, were referred to by Mr. J. Gibson Jarvie, chairman of UNITED DOMINIONS TRUST LIMITED, in an address at the company's recent annual meeting.

The Government were doing all they could to induce manufacturers to give special consideration to export trade, which was understandable. Yet there was one of the group's member companies, ENGINEERING FINANCE LIMITED, who specialized in financing highly priced equipment for manufacturers producing for export. Were the restrictions imposed by the Chancellor of the Exchequer to apply to that concern?

Inflation, the root cause of all the nation's troubles, did not spring from the use of credit in any form, but was due primarily to unproductive and reckless Government spending. Government departments should seek ways of cutting down their spending instead of stepping it up.

An Expansion Policy Gives Good Results

During the year ended 31 March last, the net profit of SYMONDS ENGINEERING COMPANY LIMITED, Cheshunt, subject only to taxation, rose by £32,531 to a total of £127,142.

These results have been accomplished in the face of rising costs and, in his statement to the company's shareholders, Mr. Douglas Symonds, chairman and managing director, attributed the improved profits to the board's policy of expanding their manufacturing facilities.

The company, who specialize in tools and sheet metal, have a further capital expenditure programme in hand at the present time. They are planning to spend around £65,000 on this work.

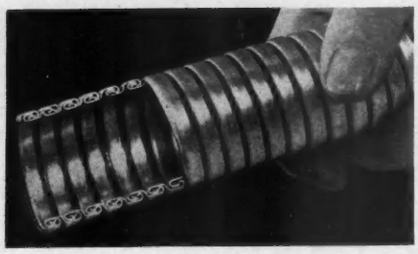
Trials With Flexible Tubing Made From Aluminium

A recent development by the United Flexible Metallic Tubing Company is the manufacture of flexible tubing in aluminium alloy. Hitherto, production of this type of tubing has been confined to galvanised steel, stainless steel and bronze.

The main reason why they have made lengths of flexible tubing in aluminium, say United Flexible, is that the product is considerably lighter in weight than in any previous metal they have used. By using a high strength alloy such as NS5, tubing for a given pressure can be made at about one-third of what was previously considered practical. This is proving of interest in road tanker and other bulk handling applications where hoses must often be manhandled, they add. Working pressures range from 300 lb per sq. in for ¾in bore tubing to 75 lb per sq. in for 12 in bore tubing.

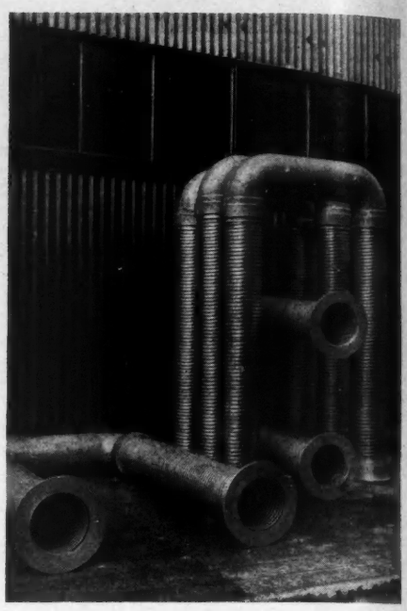
For this product, aluminium strip is rolled and slit to fine tolerances and is then helically formed by means of its interlocking edges into tubing. A continuous sealing cord is introduced between the interlocking edges to maintain pressure tightness with flexibility.

For the development of this new product, Alcan Industries supplied all experimental material. The alloy NS5 is of the aluminium-magnesium type and has been supplied in the soft condition with a proof stress of around 6 tons per sq. in. This is the type of aluminium alloy which Alcan have been actively promoting for use with liquefied gases such as liquid methane. Whether flexible tubing made by this process from the alloy will be suitable for handling liquid gases will probably depend as much as anything on whether the sealing cord will continue to provide a seal after flexing. All known rubbers go brittle at these temperatures.



The illustration shows several 8 in bore assemblies on which Shell Tankers are carrying out trials for flushing tanker pipelines and tanks with sea water.

Alcan Industries Limited, Banbury, Oxon.
United Flexible Metallic Tubing Company Limited, South Street, Ponders End, Middlesex.



Successes Prove Sports Coupé Made of Wood

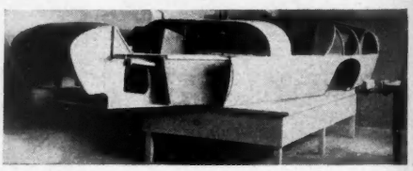
During the past two seasons some extraordinary performances have been recorded on British tracks by a sports coupé made of wood, says Gordon Wilkins, writing about the Marcos GT car. At one period it won its class in nine consecutive events.

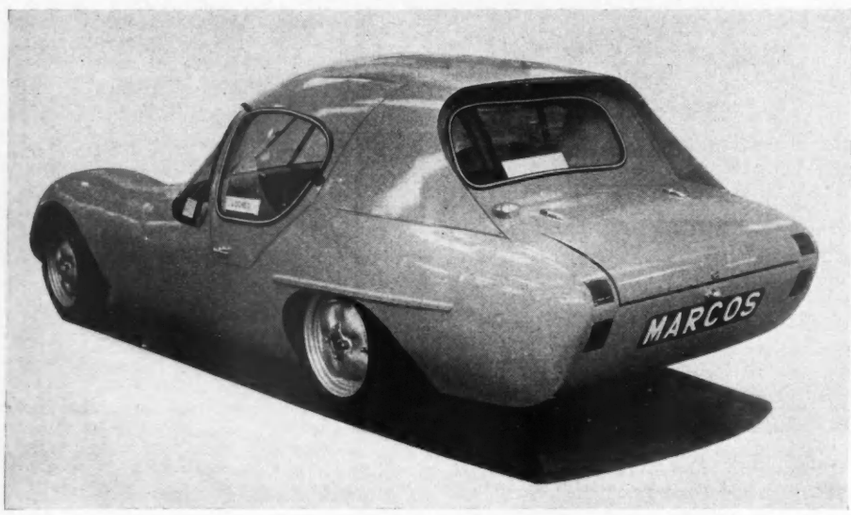
The name Marcos is derived from the names of its two sponsors, Jem Marsh, who is now responsible for production, and Frank Costin, the aerodynamic expert who was responsible for the body design and was earlier widely known for his work on Lotus bodies. Now that the required number have been sold the Marcos has been confirmed as a GT coupé and so can take part in international competitions in the 1,000 cc category.

To obtain a light strong structure at a low price, Costin used the lessons gained in construction of wooden aircraft and gliders, producing a unit-body structure of marine plywood bonded with a phenol adhesive. This kind of plywood structure is claimed to be fire resistant while shrinkage and swelling are a tiny fraction of those encountered with ordinary wood.

The basis of the structure is three box sections, forming the body sills and the centre tunnel, joined by transverse box sections forming the scuttle and the rear of the roof. The framework is of spruce with skins of plywood of 3 mm or 1·5 mm thickness.

Gordon Wilkins comments that in some ways plywood looks less suitable than sheet steel for car structures. Tensile strength at best is only a fraction of that of steel and the comparison on elasticity is even worse. Against this must be set the light weight of plywood at only one-fourteenth the density of steel. There are limits to the thinness of usable steel sheet because of corrosion and the tendency to dent when leaned on. In the Marco coupé, rigidity is obtained by using very deep hollow boxes for sills and tunnel and using lift-up doors for easy entry. The hollow sides are 14 in deep and are stiffened with frequent plywood diaphragms. The high centre tunnel rises in the form of an instrument console to join a stiff bridge formed by instrument panel, foot wells and engine bulkhead. There is a stressed plywood floor and the side members converge alongside the engine to join a transverse plywood diaphragm to which is bolted a steel tube sub-frame of 1 in square tubes carrying front suspension and steering.





Rigidity is obtained at the rear with box sections over the rear wheel arches. Further rigidity is provided by the bulkhead behind the seats which separates the seats from the luggage compartment. Fuel tank and spare wheel are attached to this bulkhead, leaving room for quite a deep and useful luggage trunk.

The plywood panels are curved in one plane only, so glass reinforced plastic mouldings are used for the ends of the rear wings and for the doors. The same material is used for the front wings and bonnet which lift as a single unit for access to the engine. The complete structure with tubular space frame, glass windscreen and plastic windows weighs only 145 lb. Ventilation is provided by cool air intakes.

Front suspension and steering are the same as those of the Triumph Herald. The rear axle with hypoid final drive is from the Standard Ten but is hung on twin parallel radius arms projecting forward from anchorages on one of the rear diaphragms. Transverse location is by a Panhard rod and attached to the front of the axle are Armstrong coil spring-damper struts which are attached to the body under the bridge structure at the rear of the roof. Normally Triumph Herald brakes with 8 in drums are used but discs can be fitted to the front wheels.

The illustration above shows the first prototype of the 1962 model being built up. The lines are slightly different from the previous model.

Non-Cracking Rhodium Plate

Engelhard Industries are now offering a chemical electrolyte for rhodium plating which is claimed to reduce the residual stresses in the plating. Hence difficulties arising from cracking in thick deposits—with resultant reduction in corrosion resistance—are avoided. Hardness is said to be in the range 700 to 800 DPN.

The electrolyte is similar in general chemical nature to the conventional type of sulphate solution, and containers, anodes and the general operating procedure are as for a conventional solution, say Engelhard. It is supplied as Engelhard rhodium syrup number 3820 and is replenished by syrup number 3821. The process was developed by the International Nickel Company (Mond).

Engelhard Industries Limited, 52 High Holborn, London WC1.

Vinyl Sheeting for Roof Lights

Marley Tile Company are now offering a pvc sheeting for roof lights which is said to be slightly cheaper than at least one other variety on the market. The price will be about 4*s* per sq. ft retail and has been made possible by installation of a continuous extruder of German origin.

Called Marleyglaze, it is designed for use as translucent roof sheeting. Initially, two profiles are being made, one with a nominal width of 30 in and 10½ in corrugations, in 4 ft, 6 ft 6 in, 8 ft and 10 ft lengths to match Standard 30 in asbestos; the other to match Big Six asbestos has a nominal width of 43 in and eight corrugations. The Big Six variety will be available later in the year, say Marley, and with its introduction lengths of both sheets will be from 3 ft to 10 ft in 6 in increments. The thickness of the sheet is $\frac{1}{16}$ in and one sq. ft weighs about 8 oz.

Cross corrugated Marleyglaze is available in continuous roll lengths up to 30 ft, in widths of 2 ft 7½ in and 4 ft. In this type of manufacture the sheeting is corrugated across the width rather than down the length of the sheet.

Marleyglaze is said to permit up to 82 per cent light transmission and is being produced in natural translucent and also red, green, yellow and blue. Marley say that this is the first extruded corrugated vinyl sheeting to be made in this country but at least one other firm has been offering a similar product. For instance, BX Plastics have been offering sheets of corrugated pvc made from calendered film which is subsequently pressed and vacuum formed into corrugated sheets.

Marley Tile Company Limited, Sevenoaks, Kent.

Order for Welded Finned Tube

Over 600,000 ft of welded finned tube made by what is called a new process is to be supplied by Extended Surface Tube Company for use in the boilers of Dungeness nuclear power station. This company is the one jointly owned by ICI and Stewarts and Lloyds.

The finning machines used for the order were designed and manufactured by Stewarts and Lloyds at their Corby works. The process uses welding current generators said to be among the most powerful of their type to join cold rolled strip as it is helically wound on to form the fin. As a result of strict control, a weld bead is produced which is small and claimed to be consistent in quality; thus it allows a large number of fins per inch. Up to seven fins per inch are accepted as standard, say the makers, which is probably the highest number ever produced in welded fin tube. The process gives good physical properties and allows tight radius bends.

The size range of the tubes produced will complement the company's Integron finned tube —originally an ICI product made under licence— which is made by a rotary extrusion process. More than 2 million ft of Integron have been used in the boilers of the Bradwell and Berkeley nuclear power stations and in the Tokai-Mura Japanese nuclear power station.

Extended Surface Tube Company comment that an interesting feature of the Dungeness order is that some of the tubes for high pressure duty will be supplied in 27 ton minimum tensile steel to BS 3059/13. It is believed that this is the first time that this material has been supplied in the form of welded fin tube. The low pressure tubes will be made from 20 ton minimum tensile material to BS 3059/3. All are electric resistance welded tubes.

Extended Surface Tube Company, Broad Street Chambers, Birmingham.

Composite Covers Protect Aircraft

The latest packaging project undertaken by Evens Kirby (Plastics) is illustrated here. It is a completely sealed cover for an entire Scimitar aircraft. This was sealed with the wheels exposed so that it could be towed by road where necessary, and the makers say that the aircraft was flying in three days from docking in Singapore. This, they say, compares very favourably with previous shipments where the aircraft was stripped and boxed, therefore taking several

weeks of reassembling and testing before flight.

The covers used by this firm are described as being a laminate of Melinex polyester film with nylon and butadiene. Being moisture proof, they are used for packaging and storage of various corrodable articles. For one piece bags up to about 300 sq. ft surface area they are normally sealed with gas tight zip fasteners. However, for the Scimitar packaging this bag had overseals and ring seals as well as conventional zip fasteners.

Evens Kirby say they are currently engaged almost exclusively in packaging for the Fleet Air Arm. They package the Avon engine for the Admiralty as well as Double Mambas, Gyron Juniors, Gazelles, Ghosts and Paloustes. These reusable cocoons are also made for electronic equipment.

Evens Kirby (Plastics) Limited, Works Road, Letchworth, Hertfordshire.

Epoxy Glaze Like Vitreous Enamel

The concessionaires in Great Britain for an epoxy resin coating formulation say that almost without exception their NT Glaze is a perfect substitute for vitreous enamel. This underlines the fact that vitreous enamelling is still held by many firms to be an attractive sort of finish. NT Glaze has the advantage in that it is flexible yet is hard and chip-proof.

Wiederhold (Great Britain) who are selling it in this country say that one of the largest manufacturers of washing and and spin drying machines in the United Kingdom has been using this material for many months as a coating for the internal bowls.

This formulation is a two part one and it is claimed that thick coatings may be obtained in one application. Surfaces should have been freshly sand-blasted and do not need pretreating such as by phosphating. Wiederhold say their laboratories are at the moment completing their tests with an undercoat system which will eliminate the need for sand-blasting. Coated work may be force dried at temperatures not exceeding 95° C or can be air dried without any detriment to the final finish, the resultant surface being resistant to detergents, petroleum derivatives and ultra-violet light.

Wiederhold (Great Britain) Limited, Dale House, Kirkdale Road, Leytonstone, London E11.

Plastic Putty in Two Parts

When two putty-like materials which make up Talurit plastic putty are mixed together, they begin to set hard. The two parts are a mineral-filled resin and another mineral-filled component containing a hardener; when these two are completely integrated in equal parts—which is easily effected in the hands—they form a workable putty which sets in anything from 1½ to 18 hours depending on the temperature.

The material is made by Cable Covers Limited,

and they make the claim that the putty is capable of adhering to anything. The makers recommend that it be considered for electrical applications including the setting and affixing of shrouding, also insulating or waterproofing terminals, conductors or cable ends. In support of this recommendation the makers quote the following figures from independent tests: ultimate compressive strength, 11,200 lb per sq. in; ultimate tensile strength, 700 lb per sq. in; dielectric strength, 253 volts per mil; water absorption, 2·7 per cent.

Cable Covers say this material, when set, can be machined, drilled, tapped or threaded. It can be used for repair of leaks and weaknesses in vessels, piping or castings, and can be used in locations which will need drilling out or tapping to receive a stud or similar component. The illustration shows how the Talurit putty can be moulded round a cable.

Cable Covers Limited, St. Stephen's House, Westminster, London SW1.

New Use for Precision Tube Fabrication

A remarkable example of tube manipulation has recently been completed for the National Gas Turbine Establishment. A gas diffuser wall has been formed from stainless steel tubing.

AN UNUSUAL gas diffuser wall in the form of a stainless steel tubular coil some 50 ft long and 11 ft in diameter at its widest part has been built by Accles and Pollock for the National Gas Turbine Establishment at Pyestock. Nearly 4,000 ft of special non-circular section tubes were used in its construction and the total weight, together with connections, stiffeners, and other ancillary fittings, is 16 tons. The purpose of the coil is to protect the shell of the diffuser from high-temperature and corrosive exhaust gases during simulated flight testing of aero engines.

Heat transfer rates and consequent high thermal gradients dictated a thin wall design, but the large diameter and high gas loading demanded a robust construction. These conflicting requirements were best met, it was decided, by a water-cooled tubular coil contained within, and supported from, the main pressure vessel. In order to obtain a reasonably smooth inner wall for the expanding gases the coil was designed using flat sided oval section tubing, a type of design which presented several interesting production and manipulation problems.

The intake end was to be of a larger overall diameter than the main body of the diffuser, both parts being made from parallel sided tubing but with the connecting part made from tubing with a conically shaped section. This is illustrated in the sketch in Fig. 1. The flat sided oval section tubes used in the parallel portions are shown in Fig. 1a and Fig. 1c and the conically shaped section in Fig. 1b.

To preserve the uninterrupted inner contour, this conical section was designed so that when it was manipulated into a helical coil the major axis of the section formed a straight line on the inside of the coil, as did the flat sided oval sections in the parallel portions of the wall. The smooth inner surface and the stepped external contour of the coil can be clearly seen in Fig. 1.

In view of the elevated temperatures and the corrosive nature of the exhaust gases, the material selected was austenitic stainless steel to British Standard Specification En 58B. (18 per cent chromium, 8 per cent nickel, titanium stabilised). All of the tubing used was cold drawn seamless, having a wall thickness of 12 s.w.g. produced from extruded hollows.

In order to overcome handling problems during its fabrication and to facilitate transportation, the coil was produced and delivered to Pyestock in twenty sub-sections, and finally assembled in the test cell on site. The larger, or intake, end consisted of two parallel sub-coils, each of 11 ft 5 in outside diameter and 11 ft inside diameter. The tapered portion which followed was made up of four sub-assemblies, and the main body of fourteen parallel sub-assemblies, each of 8 ft 11 in outside and 8 ft 6 in inside diameter.

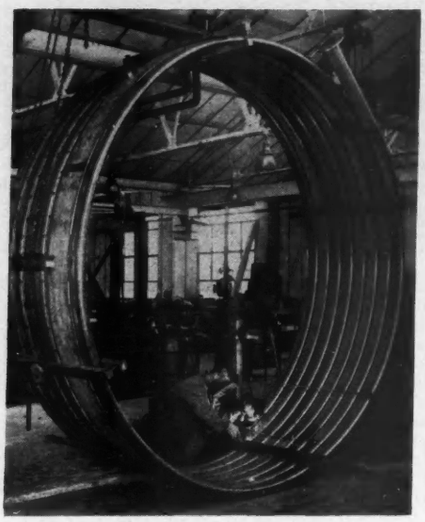


Fig. 2 Intake end of coil during fabrication.

The intake parallel portion of the coil is shown in Fig. 2 during production and one of the conically shaped coils in Fig. 3. In this latter illustration can be seen the special tube section shape giving the "smooth flow" inner surface and the stepped outer surface. Also shown in this illustration is a heat resisting high nickel alloy braiding which protects the walls of the test cell by preventing the escape of high pressure exhaust gases through the narrow gaps between the wraps of the coil. The braiding was located by clips of a similar composition to the tubing, argon-arc welded on to the tubular sections. Each of the twenty sub-assemblies was provided with upwards of 500 such fittings. The runners and stiffeners were attached in the same way.

CONNECTING SUB-ASSEMBLIES

Water connections between each sub-assembly were made by flanged joints on the outside of the coil, except in the case of the larger intake end. Because of lack of space between the wall of the cell and the coil, this connection was made on the inside of the diffuser.

The seamless non-circular section tubes used in the construction of the coil have equivalent diameters (i.e. of equal periphery) of up to 4½ in round tubing and a common wall thickness of 0·104 in. The maximum lengths of raw material which can be obtained, and consequently the finished lengths which can be cold drawn, of such sizes, are somewhat restricted. Each coil assembly was therefore constructed from semi-circular laps and built up by argon-arc welding.

At the design stage it was realised that re-setting of the individual coils was not possible on final assembly in the test cell and consequently tolerances on all dimensions would be critical.

Fig. 3 One of the conically-shaped portions

On the diameter of the coils, for example, a total tolerance of $\frac{1}{16}$ in was worked to and a similar tolerance applied on the gap between turns of a coil and between coils. The maximum permissible variation of the overall longitudinal dimension of each coil section was $\pm \frac{1}{16}$ in. The circumferential position of the four runners argon-arc welded to each coil section was $\pm \frac{1}{4}°$ Other critical tolerances applied to the flanges and the gap between coil ends and, as a result of these stringent tolerances, no undue difficulties were experienced during installation. Each coil was hydraulically pressure tested to 120 lb per sq. in before delivery to site.

The test cell in which the coil is fitted forms part of the Engine Test Facility at Pyestock, where aero engines may be tested under a variety of simulated flight conditions. Data concerning the behaviour and performance of engines under varying conditions of temperature, pressure and velocity are essential. Simulated tests at operating speeds and altitudes can save valuable time in the development of engines and provide the necessary information without risk to test pilots' lives. Further, it is frequently the case that there is no available flying test-bed capable of testing the most advanced engines.

Different test cells are designed to cover different aspects of testing and one of the aspects for which this test cell was specifically designed was the high altitude testing of jet engines with full expansion of the exhaust nozzle. The specific purpose of the diffuser is to slow down the high velocity, high temperature gases from the engine under test, in order that these gases may be passed through a water tube cooler, and thence through exhausters which serve to reproduce altitude conditions. The profile of such a diffuser is critical if the high kinetic energy of the gases is to be converted into pressure energy, and thus effect a considerable saving on the installation of expensive exhauster machinery.

The coil assembled in the test cell at Pyestock is shown in Fig. 4. Appreciation is due to the National Gas Turbine Establishment for information supplied and for permission to publish this article.

Accles and Pollock Limited, Oldbury, Birmingham.

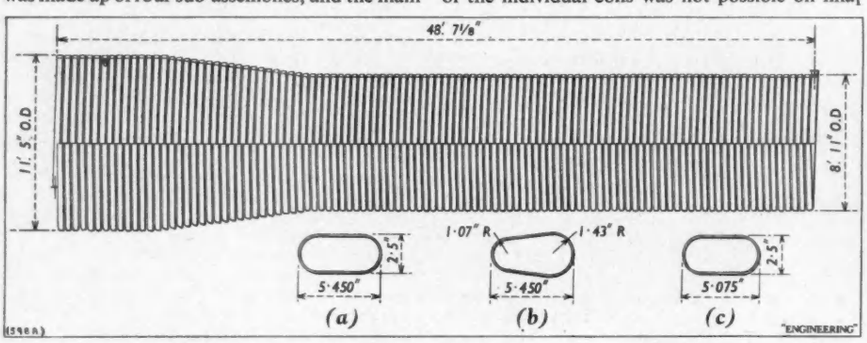


Fig. 1 Cross section of the general arrangement. The tube sections are shown at A, B and C.

Fig. 4 The assembled coil from the inlet end.

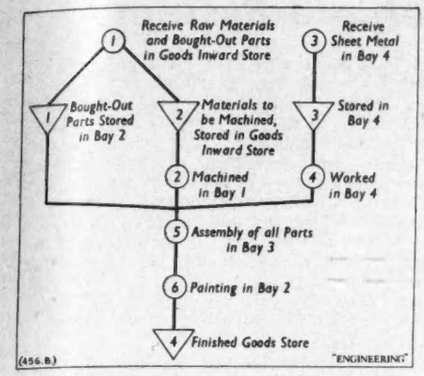

Receive Raw Materials and Bought-Out Parts in Goods Inward Store
Receive Sheet Metal in Bay 4
Bought-Out Parts Stored in Bay 2
Materials to be Machined, Stored in Goods Inward Store
Stored in Bay 4
Machined in Bay 1
Worked in Bay 4
Assembly of all Parts in Bay 3
Painting in Bay 2
Finished Goods Store
(456.B)
"ENGINEERING"

Fig. 1 Operation process chart showing overall production in the factory.

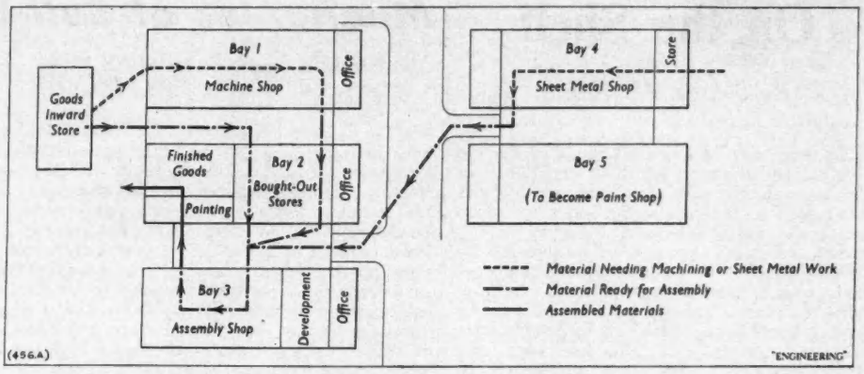


Fig. 2 Flow diagram showing the factory layout. Each of the five bays is of approximately 30,000 sq. ft area. Bays 1, 2 and 3 are divided from Bays 4 and 5 by a highway.

Work Study in a Small Batch Factory

Where small batch production is unavoidable, it is sometimes argued that work study cannot be applied to advantage. This company's successful introduction of the technique is an illustration of the fallacy of this argument.

In an age when all the economic pressures are in the direction of product standardization, enforced diversification can present a company with difficult production problems. This has happened in the case of John B. Pillin Limited, a member of the Castrol group, which, to fulfill its prescribed role in group policy, has to be an economically viable unit producing a wide variety of industrial and automotive lubrication equipment. At best, production runs are short; at worst, they are one-off.

The factory employs nearly 400 people on the outskirts of West Hartlepool and now covers approximately 150,000 sq. ft in five equal-size single-storey bays. Two of these bays were opened in 1960 and, to complicate flow production further, are separated from the main factory by a highway used by the public.

Among the principal products are oil dispensers, pumps, cabinets and tanks, lubrication batteries, hosereel and wall panel units, lubrication guns, waste oil units and grease pumps in a variety of sizes, sometimes to a customer's own specification. Under these conditions it is virtually impossible to establish tight flow production, but the general lines of flow, shown in the operation process chart in Fig. 1 and in the flow diagram in Fig. 2, have been method studied to eliminate unnecessary handling.

The process begins at the goods inward store. After initial inspection, materials requiring machining are held there prior to transfer to the machine shop, while " bought-out " components are transferred to the stores in Bay 2 where they are readily available to the assembly section. An exception is sheet metal, which is received in the special storage area in Bay 4.

Bay 1 is the machine shop consisting of capstan, drilling, grinding, milling and automatics sections. Part of the shop is walled off as the tool room, housing, among other equipment, a Newall jig borer which helps to reduce to economic proportions the set-up times which are so crucial in small batch production.

The majority of the machine shop plant is of a general type, because the batch sizes make it uneconomic to jig up for special applications, but it does include a bank of capstan lathes fitted with Nickols electronic sequence control equipment. There are also two six-spindle Wickman automatic lathes. High machine utilization is maintained through the service operators, and the machine setters.

From machining, components pass through Bay 2 and, together with " bought out " components from the stores there, are delivered to the assembly sections in Bay 3. Meanwhile, sheet metal work has been carried out in Bay 4, and this too is delivered to the assembly section if necessary. After assembly, there is painting and dispatch at the end of Bay 2.

A good example of the layout planning carried out by the work study department is the new sheet metal shop. Setting up the shop demanded careful planning since the management stipulated that the department should become operational with little or no interference with output. This was accomplished with the cooperation of works and maintenance management, though the removal was complicated by the need for the heavier plant to be moved by an outside contractor who required two weeks' notice of a firm removal date.

Since the goods inward store is at the far end of the factory and across the highway, the sheet metal store has been placed within the sheet metal shop, as shown in Fig. 2. From this store, there is direct product flow, all within Bay 4, through a number of operations including guillotining, brake pressing, circle cutting, fly pressing, swaging, bending, rolling, drilling and welding. The fact that the guillotines are immediately adjacent to the store facilitates handling by reducing the sheet to comparatively manageable proportions at the first operation.

After sheet metal shop treatment, the components are transferred across the highway for assembly work in Bay 3 and painting in Bay 2. When a current project for laying out Bay 5 as a paint shop has been completed, some of the journeys across the highway will be eliminated.

STOP WATCHES BY REQUEST

About four or five years ago, after the layout and the assembly and machine operations had been partly method studied, it was decided that the time was opportune to begin introducing time study and work measurement. From the start, top management appreciated that consideration of the human factor is of major importance in gaining acceptance of time study on the shop floor. They recognised the importance of prior and unhurried education and consultation.

This careful and unhurried preparation has paid off in the form of the very good relations that continue to exist between the work study department and the shop floor. A significant part in the process of spreading a true appreciation of work study, particularly work measurement, was played by a booklet, *A Simple Introduction to Work Study*, which was distributed to all employees. Unlike some literature of similar aim and title, this booklet states the reasons for, and aims of, work study in a straightforward and non-technical manner.

Beginning with a statement of the need for greater productivity and a recognition of the interdependence of everyone in the factory, the booklet describes how work study can help to promote efficiency while making work easier. There is emphasis on the fact that the technique can only succeed with the cooperation of management, supervision and operators, and that it is necessary to throw off the natural human antipathy to change. Simple definitions are given of the basic aims of method study, time study and effort rating, and the process of using effort rating to normalize study times is described.

Having used the booklet and appreciation courses to demonstrate to management and managed alike the value of work study, it was decided not to introduce time study immediately but to wait until there could be no doubt about its acceptability on the shop floor. However, after a few weeks the operatives requested that they be time studied instead of continuing with the more arbitrary rate fixing technique. It is not unusual for operatives to ask for work measurement after seeing the proof of the pudding in adjacent departments, but this is a much less common example of operatives asking to be time studied without the incentive (sometimes a little unethical) of seeing their colleagues taking home bigger pay packets.

Now, the work study department is working flat out on setting up standard times. The sheer variety of product makes this a big task, though every effort is made to take advantage of common elements in dissimilar end products. At present, there is no real attempt at making up synthetic data as such but it is likely that this will come as the work study department accumulates more information on standard times.

The department's activites also extend into the field of organization and methods, since this company does not recognize the common and spurious division between work study and O and M. Office routines tackled have been planning procedures, progressing, stock control, buying and other smaller jobs requested—again the emphasis is on " requested "—by the heads of other departments.

However, though it is company policy to eliminate any element of compulsion from the application of work study, the department's importance is recognised by the fact that it is directly responsible to the works director. At all levels the department works through the established management structure and, on the shop floor, emphasizes that method study is carried out through the foreman. Negotiations on work measurement are carried out with the operator direct, but it is firmly understood that the foreman is kept in the picture.

The success of this company's work study policy—and the wholehearted acceptance and cooperation it receives on the shop floor and among management—is an example of how the technique can be applied to small and varied production runs.

John B. Pillin Limited, Hartlepools Industrial Estate, West Hartlepool, Co. Durham.

On the Shelf

By Frank H. Smith

THE other evening I tied a knot in my hankie to remind me to telephone the Editor in the morning, but with this warm weather you don't need to use the hand-rolled hems much and I was nearly too late. I usually remind myself, overnight, by putting a note in my tobacco pouch but on this occasion I could not find a piece of paper with the required amount of non-absorption. This reminder business can be a bit of a problem. Diaries are no good because they are not urgent enough (do *you* look at your diary every day?). My Mum used to put the coal scuttle on the table and then wonder what damned fool had put the coal scuttle on the table. As a spectacle wearer I suppose I could always cover one lens with condensed milk.

The *Hull Commercial and Technical Bulletin* (N. E. Smith, Technical Librarian, Kingston upon Hull Technical Libraries) for July has an editorial on "Scientific and Technical Information in Industry." They quote the public library cooperatives such as LADSIRLAC (Liverpool), SINTO (Sheffield), TALIC (Newcastle), and, of course, HULTIS (Hull). The last (which is what they are getting at, of course) is Hull Technical Interloan Scheme, representing 35 member libraries with a periodical availability approaching 1,500. For sheer information, you cannot beat ENGOTS (ENGINEERING On the Shelf). I do beg leave, however, to query Hull's placing of *Space research by rocket and satellite* under Astronomy.

Micro Methods (East Arsley, Wakefield) announce that they now "do" all microcards published by Microcard Editions of America without additional charge. Catalogue available on request.

I am particularly fond (and I have a great capacity for fondness) of the Special Technical Publications of the American Society for Testing Materials. Do you know them? They are up in the 270 region now and consist largely of the papers of symposia on, of course, materials, structures and their like and their ailments and reactions to circumstances. Things like low temperatures and acoustic effects and so forth. They are very easy on the budget—round $3 or so—and the ASTM will keep you advised of what's what. And why do I suddenly speak thus kindly of an established publication? Because I've just catalogued about half a dozen of the blasted things.

The Statistical Review of the World Oil Industry is with us again. The 1960 edition can be got from B.P., Britannic House, Finsbury Circus, London EC2.

An organization called Pax Atomica (Fawley Bureau, Morley House, 320 Regent Street, London W1) publishes *Atom Review*, which highlights the peaceful uses of atomic energy. I have *not* read it thoroughly but if you are interested in atomic gardening, this should be your material.

In one of the papers to the Aslib Aero Group Annual Conference, Dr. Booth (Birkbeck College) emphasized the dangers of ambiguity when machine translation is considered, I was reminded of this by seeing a Northrop advertisement for their T-38 supersonic trainer aircraft: "Fastest Step to Combat Readiness." Verb or noun?

Always good for an interesting snippet, the *Soviet News* comes up with Yakutian (whassat?) hunter Pyotr Zakharov, 105 years old who, every year, catches between 500 and 600 squirrels, 40 to 50 ermines, 10 to 15 foxes and a number of bears and hares. What it does not tell is whether he traps them or grabs them by the tail.

Deutscher Normenausschuss (the German BSI) go ahead with their translation of standards into English. A new list is available from Berlin W15, Uhlandstrasse 175, of those published in June. I wonder why they don't give the prices?

Mechanics of Soil-Vehicle Systems

Off-the-Road Locomotion. By M. G. BEKKER. *University of Michigan Press, Ann Arbor; Cresset Press, London.* (70*s*)

It is almost incredible that only two books should have been published so far in English on the mechanics of soil-vehicle systems. Tracked tractors and other vehicles intended specifically for operation off the road have been under development for more than fifty years, that is, about as long as aircraft. Yet it was only five years ago that the first analytical treatise appeared on the relationship between cross-country vehicles and their environment. This was the *Theory of Land Locomotion*, by M. G. Bekker, published in 1956 by the University of Michigan. Now the same author has given us the second book, on *Off-the-Road Locomotion*.

Colonel Bekker's new book is a direct follow-up on his pioneer work. It does not supersede the latter, which is firmly established as a text-book, but continues the exposition of the subject, with particular reference to developments which have taken place since the first work was written. The follow-up is well justified not only because of the general dearth of literature in this field but also in view of the increasing amount of effort directed during the past ten years, particularly in the United States, at a better understanding of soil-vehicle mechanics, which was clearly reflected in the First International Conference on the Mechanics of Soil-Vehicle Systems held recently in Italy. The value of the book also accrues from the fact that Colonel Bekker has actually initiated several of the recent developments, as well as being for many years the leading exponent of a more analytical approach to off-the-road vehicles.

To derive the fullest benefit from the new book one should be familiar with its forerunner, especially as it tends towards brevity just as the original work tended towards encyclopaedic comprehensiveness. It does, however, present a complete picture of the problem, starting with a general discussion of the different modes of locomotion and of the limitations of current types of vehicles. If further progress is to be made, off-the-road vehicles will have to be better adapted to the environment in which they operate and this, in turn, demands a knowledge of the physical characteristics of the soil, on which the author rightly places considerable emphasis. It is surprising for how long no serious effort was made to place the properties of the soil on a quantitative basis, but a semi-empirical system has now been established as a result of the author's work at the Land Locomotion Laboratory of the US Army Ordnance Tank-Automotive Command. Thus one can, at last, evaluate with a reasonable degree of accuracy the thrust generated at the soil by the wheels or tracks of vehicles, the different components of resistance to motion, and various other aspects of vehicle performance. In showing how this can be done, the author deals with such simple but often misleading notions as that of "flotation" and the perennial problem of wheels versus tracks, which is still generally treated on a subjective basis.

In addition to the establishment of mathematical models of soil-vehicle relationships and the consequent ability to predict vehicle performance in different types of terrain, the author discusses a number of recent developments in vehicle design. Two which are of particular interest are the direct result of his ideas, the spaced link track and the condual tyre, both of which can provide greater drawbar pull than conventional tracks or tyres. Another significant development is that of articulated tracked vehicles, which have been revived in recent years in the United States and Canada. They overcome the inherent limitations of conventional tracked vehicles with laterally rigid tracks and skid steering and make it possible to design longer, narrower vehicles which are better suited to off-the-road operation, as Colonel Bekker frequently brings out.

The second to last chapter contains well-founded criticism of the common approach to soil trafficability based on simple measurements with cone penetrometers and indicates an alternative and more rational approach to assessing vehicle mobility which, of necessity, involves vehicle as well as soil parameters. In conclusion there are some pertinent comments on the organization of research, which Colonel Bekker is well qualified to give having been the head of the pioneer Land Locomotion Laboratory from its inception until last year and now being head of the newly formed Land Mobility Laboratory of the General Motors Defense Systems Division. The last fact gives added interest to this valuable book and, at the same time, provides yet another illustration of the growing attention to the study of off-the-road locomotion.

R. M. OGORKIEWICZ

Concrete and Steel

Structural Concrete. By KURT BILLIG. *Macmillan.* (84*s*)

Reinforced Concrete. By OSCAR FABER. 2nd Edition. By JOHN FABER and FRANK MEAD. *Spon.* (75*s*)

The Steel Designers' Manual. By CHARLES GRAY, LEWIS E. KENT, W. A. MITCHELL and G. BERNARD GODFREY. 2nd Edition. *Crosby Lockwood.* (50*s*)

Design of Steel Structures. By BORIS BRESLER and T. Y. LIN. *Wiley, New York and London.* (78*s*)

The publication of these books—two devoted to structural concrete and two to structural steel—causes one to ponder yet again on the similarities and differences of the two materials for structural work.

In very recent years one revised and one new Code of Practice relating to structural concrete have appeared, namely, CP 114 and CP 115. Correspondingly in steel two revised British Standards—BS 153 and BS 449 have been published.

John Faber and Frank Mead, who have expanded and largely re-written Oscar Faber's original book, draw freely on CP's 114 and 115 for their examples of design of structural elements. Dr. Billig's book, which has the character of a minor encyclopaedia, quotes not only from the British codes but includes extracts from German, Russian, American and French codes where these are relevant. In the case of unusual structures where no codes exist guidance based on accepted good practice is given.

A second edition of the *Steel Designers' Manual*, rather than a further reprint of this deservedly well-known book, has enabled the authors, by largely re-writing the chapters on design, to incorporate the requirements of BS 449, 1959. Bresler and Lin base their numerous design examples on the various American Codes of Practice related to steel structures.

The majority of steel structures in Great Britain are made from one of three steels—mild steel to BS 15, high tensile steel to BS 548 or BS 968—and there is little that the engineer can do to modify the properties of these, his basic materials.

In concrete work, however, enlightened techniques now enable the designer and constructor, who so wish, to tailor their material to a set of particular requirements. Nonetheless, in contrast to steel, concrete has the inherent drawbacks

of non-uniformity, weakness in tension and is the victim of shrinkage and creep.

There is no doubt that, over the last few decades, concrete has been making steady inroads into what used to be the domain of structural steel—both in building and bridge-work. The reasons for such victories are, of course, principally economic; one of the greatest, perhaps, being the steady improvement in the quality and strength of concrete obtainable at site without a proportionate increase in its cost. In addition, concrete is naturally fire-resistant, so that in many buildings reinforced concrete frames have superseded steel frames clad with concrete for fire-resistance. Further, steel will require painting many times in its life to avoid the ravages of atmospheric corrosion, but good concrete, placed by the correct techniques, will protect steel reinforcement against such corrosion almost indefinitely in many atmospheres.

Faber and Mead give lucid consideration to such matters as mix design, basic properties of concrete, shrinkage and creep, although, in comparison with Billig, the treatment is somewhat brief. The latter author gives very detailed coverage to these matters, but in some places presents so much information that careful reading is required to resolve what, at first sight, appear to be contradictions.

Whereas a relatively short time ago only the elastic behaviour of structures was considered in design, the importance of plastic behaviour and the concept of ultimate strength is now recognized for both steel and concrete structures. All the books give consideration to these facets of design and, in addition, Bresler and Lin devote considerable space to the elastic and plastic behaviour of end connections, whether welded, riveted or bolted. A clear understanding of the behaviour of such connections is essential to the steelwork designer.

Steel construction is essentially concerned with relatively thin elements, while concrete sections are, in general, much thicker. As a result, the dangers of local buckling of the elements of a steel member, or of the member itself, are important, whereas in concrete construction their significance is generally much less. While the *Steel Designers' Manual* adequately explains the application of BS 449 to achieve stability of various structural elements, Bresler and Lin give much basic theoretical information and show, in many instances, the sources from which the requirements of the various American Codes of Practice were derived. The American book also covers such matters as shear centres, shear flow and torsion combined with bending in asymmetric and symmetric thin walled members.

In concrete work the required shapes of sections are achieved by casting, while in steel they are often built up from rolled elements by welding or riveting. It is essential when designing such built-up sections in steel to ensure that all surfaces exposed to atmospheric corrosion are very easily accessible for cleaning and painting. Careful attention must also be given to the arrangement and method of joining the elements to ensure that the minimum amount of shop work is required. The finished section, too, must be sound for the purpose it is to fulfil.

Quite a few sections illustrated by Bresler and Lin fail on one or more of these requirements. Examples are angles back to back separated by central gusset plates, complex and clumsy riveted sections, the seating of crane rails on the "soft" flange plates of box members and the forming of box members by butt welding plates to the edges of the flanges of two fabricated I sections. Undeniably such details have often been used in the past, but they would be better omitted from a modern book on structrual steel.

The most striking development of recent years in concrete work has been, of course, the ever growing use of pre-stressing. This technique has also been used to a very limited extent in steel. Faber and Mead devote over 60 pages to a description of the principal systems and to explaining the fundamental theory. Billig's treatment of the subject is understandably brief since another book on the subject stands to his credit.

It is felt that Dr. Billig's book will be of very considerable use to both students and practising engineers for the great diversity and detail of the information which it contains. Faber and Mead have written in a style, in parts almost conversational, which, coupled with their lucidity, should give their book an appeal particularly among those studying concrete *ab initio*.

Bresler and Lin's work is a useful addition to the books on design of structural steel since a number of problems, often omitted from other text books on this subject, are dealt with quite comprehensively. Five printings of the first edition of the *Steel Designers' Manual* since 1955 amply testify to the appreciation of this work. Its value will be enhanced by its revision to suit the latest standard specification.

All the books contain bibliographies; those given by Billig, and by Bresler and Lin, being particularly comprehensive.

B. P. WEX

Cobalt Plays a Greater Part

Cobalt: Its Chemistry, Metallurgy and Uses. Edited by ROLAND S. YOUNG. *Reinhold, New York; Chapman and Hall, London.* (£6)

When Roland S. Young's Monograph on Cobalt appeared in 1948, the whole subject could be accommodated within the covers of a relatively slim volume, liberally supplied with illustrations of plant and products. During the ensuing 13 years, however, considerable advances have been made in the technology of cobalt, and the present book, now given the sub-title "Chemistry, Metallurgy and Uses," is more than double the size of the original. The illustrations have been squeezed out to make room for a great deal of additional data, and, in fact, the book has largely been re-written, the author now appearing also as editor, having called upon the services of collaborators for some of the chapters.

In general the plan of the book remains the same as before, with chapters dealing with history and general economics of the element, its ores and occurrence, extractive metallurgy and chemistry, including a new—and incidentally by far the longest—chapter on coordination compounds of cobalt. Although the last subject is of considerable importance in modern theories of chemical bonding, it will be of interest to chemists rather than to engineers.

Discussion of metallurgical aspects of cobalt includes phase diagrams, magnetic alloys, electrical and electronic uses, high temperature high strength alloys, tool steels, cemented carbides and electroplating. One rather surprising omission in the chapter on high temperature alloys in view of the importance of cobalt-bearing alloys in gas turbine aero-engines, is the complete lack of data on the resistance of these alloys to high temperature oxidation and corrosion of burnt gases arising from impurities in fuel oils.

The remaining chapters deal with glass, ceramic and pigment applications, cobalt catalysts, the role of the element in biology and biochemistry, and a valuable and informative new chapter on radioactive cobalt, the engineering problems associated with its manufacture, storage and use, together with a compact account of the very diverse applications of this important substance. A chapter on analytical methods for cobalt is also included.

The presentation of the book is well up to the high standards set by American publishers, and it should serve as an excellent introduction to the subject for the general reader, while the full bibliographies at the end of each chapter, as well as subject and author indexes, make it a useful work of reference for specialists. However, your reviewer hopes that the editor and publisher of this book will forgive him if he takes this opportunity to plead with American publishers in general for uniformity in quoting temperature scales, particularly when discussing metallurgical and engineering subjects. It is disconcerting to find within one chapter by one author degrees Fahrenheit and degrees Centigrade quoted without the corresponding conversion. The British reader could well wish to be spared the mental effort involved in converting from one scale to the other throughout an extended argument.

J. W. RODGERS

Steel Mill Theory—with Reservations

Research on the Rolling of Strip: A Symposium of Selected Papers, 1948-1958. *British Iron and Steel Research Association, 11 Park Lane, London W1.* (21*s*, free to Members)

If this collection of papers published in various journals during the period 1948 to 1958 is regarded solely as a tribute to the advance in the knowledge of the rolling processes which were made by the exceptional team associated with the British Iron and Steel Research Association laboratories in Sheffield, then it will serve a unique purpose in illustrating to industry that the research engineers and scientists of Britain bear more than a favourable comparison with their colleagues in any other industrial country. Similar situations are known to exist in other fields and the authors of many advanced papers must regard with some envy the licence fees which are paid overseas while the application of the principles set out in their own work remain inadequately developed in their own country.

However, although a collection of notable individual papers into a volume leads to the information being more readily available, and as a consequence, to wider dissemination, unfortunately, it may also give greater authority to the work, up to a particular date, than is desirable in a rapidly expanding field. The knowledgeable student will realise the inadequacy of even contemporary development in this field, but the technician requiring specific information may be widely misled by referring to limited research work, which is only part of the general progress.

From the technical aspect, it is pointed out within the text of the papers that the theories of Bland and Ford, and of Sims, are based respectively on complete slipping or sticking over the whole area of contact of the rolls and the work. So, within the validity of the theories representing the stress distributions within the roll gap, they both tend to over-estimate the load and torque requirements. Orowan had recognised earlier that both sticking and slipping may occur simultaneously within a practical range of rolling conditions, but the computation of his "exact" theory is laborious and makes the theory impractical as a works production tool. Moreover, as reliable data on the coefficient of friction between the work and the rolls has not yet been determined, independent of a rolling theory, the

apparent increased accuracy of the Orowan theory is largely invalid.

It is also clear that little is known about the shape of the roll contact area. Orowan shows experimentally that the contact surface has a far greater radius than as calculated by the Hitchcock Formula, which is widely used in the various theories, and among the other effects which will significantly influence the roll load and torque are strain and temperature fluctuations. It is, therefore, apparent that the basic theories have only tentative application, except where the relevant data have been obtained under comparable conditions, or from similar practice.

In papers on other than the calculation of roll loads and torques, Hill and Longman demonstrate the problem of reducing thin sheet and strip; also, papers on gauge control and tandem mill theory provide a useful introduction to the specialist concerned with the development of automatic control equipment for rolling mills.

It must be of considerable satisfaction to the authors, and BISRA, that the research work covered by these papers paved the way for the introduction of automatic gauge control, which is now established as an integral part of all strip and sheet rolling mills. The final completely automated mill cannot now be long delayed.

As the title implies, the major proportion of this collection of papers is of prime interest to the research worker engaged on advancing further the knowledge of the process of rolling. In this work, the theories and experimental results should be examined critically in the light of more recent developments in techniques. The man directly concerned with rolling practice or mill development will rarely have the opportunity or the specialist training to enable him to extract from the collection of scientific discussions the data and equations which are of unquestionable application to his particular industry.

The mill designer could be tempted, in the interests of economy, to accept the results of theoretical calculations, particularly where the formula used has been derived from similar normal conditions. The designer, however, will bear in mind that progress has not yet eliminated accidents particularly in rolling mills handling large masses at fast rates and, therefore, due regard must continue to be paid to empirical law. Moreover, unknown variables render the most reliable formulae subject to an error of 25 per cent.

To serve the purpose of the rolling mill development engineer and manager, a companion review, providing the relative data and information to satisfy his requirements, would be of outstanding value, and a primary asset in the training of engineers and operators of rolling mill plant.

H. H. ASCOUGH
J. F. WALLACE

New Books

Sir George Cayley: The Inventor of the Aeroplane. By J. LAURENCE PRITCHARD. *Max Parrish.* (42*s*)
Full-length definitive biography of the versatile baronet scientist who invented the aeroplane and glider, and pioneered aeronautical research. His other inventions were the tension wheel, the hot air engine and the caterpillar tractor. He made vital contributions in many other fields, including the founding of the Regent Street Polytechnic in 1839.

The Workshop of the World: British Economic History from 1820-1880. By J. D. CHAMBERS. *Oxford University Press.* (8*s* 6*d*)
Lively and authoritative account of Britain's transition from a primarily agricultural and commercial community to a modern industrial state acting as the world's banker, collier and trader.

Britain's New Towns. By A. C. DUFF. *Pall Mall Press.* (10*s* 6*d*)
Addressed to the general reader, this is a factual and down-to-earth account of the work involved in creating a New Town from scratch, and in establishing its industries. The author was general manager of Stevenage New Town Development Corporation from 1947 until 1957.

Dynamics of Rigid Bodies. By WILLIAM DUNCAN MACMILLAN. *Dover Publications, New York; Constable, London.* (16*s*)
Unabridged republication of the 1936 edition. Formal approach, using geometrical and analytical methods, to the classical theory of the dynamics of particle systems and rigid bodies. Numerous worked examples and illustrations are given, together with nearly 200 exercises.

The Stability of Motion. By N. G. CHETAYEV. 2nd Edition. *Pergamon Press.* (60*s*)
Essentially, Chetayev is concerned with the application of Lyapunov's classical work on the differential equations of perturbed motion to derive exact solutions of the stability of dynamic systems. This is for applied mathematicians, not design engineers.

Flexural Vibrations of Rotating Shafts. By F. M. DIMENTBERG. *Butterworths.* (60*s*)
The main aim is to establish and analyse (principally from the qualitative aspect) the basic factors connected with the vibration of high-speed turbo shafts, with special reference to design and strength calculations. The work extends to the determination of vibration frequencies and critical speeds, and to problems of natural vibration. A bibliography of 52 key references is appended. This was originally published in Russia in 1959.

Plastic and Elastic Design of Slabs and Plates. By R. H. WOOD. *Thames and Hudson.* (63*s*)
The use of simple yield-line theory, and of other more recent developments in the plastic design of slabs, is examined in the light of "limit analysis" theory and in relation to the composite action of beams and slabs (especially reinforced concrete floors). The theory is illustrated with 22 worked examples of various degrees of difficulty and there are accounts of practical tests. Thus all tastes are catered for—students, design and consulting engineers, research workers and lecturers.

A Guide to the BS Code of Practice for Prestressed Concrete No. 115 : 1959. By F. WALLEY and S. C. G. BATE. *Concrete Publications Limited, 14 Dartmouth Street, London SW1.* (12*s* 6*d*)
Each clause of the Code is fully explained and commented on. The emphasis is on the amplification of the recommendations concerned with those aspects of prestressed concrete construction that are not common to other forms of concrete construction. Much additional information is given and there is a short bibliography.

Thermodynamic Functions of Gases. Edited by F. DIN. Volume 3: Methane, Nitrogen, Ethane. *Butterworths.* (63*s*)
The thermodynamic properties of each gas are critically surveyed and tables given of the most reliable values of the various functions. The construction of the temperature-entropy diagram is discussed for all three gases. This series of surveys is the result of a cooperative undertaking by a number of academic and industrial organizations under the direction of DSIR.

Nuclear Energy Simplified. By JOHN ERNEST RADFORD. *Macdonald.* (28*s*)
Elementary study of the liberation, control and industrial applications of nuclear energy.

Engineering Data for Product Design. Edited by DOUGLAS C. GREENWOOD. *McGraw-Hill, New York and London.* (77*s* 6*d*)
Compiled largely from *Production Engineering Reference Book Sheets*, this manual is designed to give on-the-job aid to the production engineer. A mass of information, which can be quickly and easily adapted to specific needs, is presented in the form of charts, tables, formulae and line drawings. The coverage ranges from metals and alloys through general design analysis and mechanical systems to electronics, hydraulics and pneumatics.

Gears: Spur, Helical, Bevel and Worm. By P. S. HOUGHTON. 2nd Edition. *Technical Press.* (63*s*)
A wealth of practical information is presented in a manner suitable for draughtsmen, shop superintendents, foremen, mechanics and students.

Elementary Machine-Shop Inspection. By R. C. TATLOW. *Blackie.* (9*s*)
"Elementary" is the key-word, for the book confines itself strictly to the types of inspection performed by operatives in precision machine shops where only the conventional mechanical gauges are available. The essentially practical approach should help the inexperienced to negotiate the many and varied pitfalls which bedevil machine-shop inspection.

Modern Arc Welding Practice. By J. A. OATES. *George Newnes.* (30*s*)
A reference and instructional manual, this will appeal to both the student and the fully-fledged welder. British and foreign methods are covered, including the latest techniques such as electro-slag processes and underwater welding. Detailed information is given on the welding of Ti, Al, Ni, cast iron and a number of special steels. A comprehensive list of BS on welding and allied topics is appended.

Introductory Soil Mechanics and Foundations. 2nd Edition. Edited by GEORGE B. SOWERS and GEORGE F. SOWERS. *Macmillan Company, New York and London.* (56*s*)
Over two-thirds of the original text has been entirely rewritten to accommodate the advances of the past decade. The bearing capacity of shallow foundations and of piles is now treated and more space is devoted to the rational application of the basic principles of soil mechanics to foundations analysis and design. Material has been added, *inter alia*, on drainage, soil expansion and earth dam design.

The Reviewers

Mr. R. M. Ogorkiewicz, M.Sc.(Eng.), A.M.I.Mech.E., is a lecturer in mechanical engineering at the Imperial College of Science, London University. He has written extensively on the development of armoured fighting vehicles and is the author of the book *Armour*, as well as several articles on automobile engineering.

Mr. B. P. Wex, B.Sc. (Eng.) Hons., A.M.I.C.E. is a Senior Engineer with Freeman, Fox and Partners, consulting engineers.

Dr. J. W. Rodgers is assistant research manager in the Metals Division of Imperial Chemical Industries Limited. He is a M.Sc. in physics and a Ph.D. in metallurgy.

Mr. H. H. Ascough, M.I.Mech.E. is Senior Superintendent and superintendent rolling mills for the Steel Company of Wales.

Dr. J. F. Wallace, B.Eng., Ph.D., is a Senior Research Fellow at the University of Sheffield and was formerly research assistant in charge of Metal Deformation.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Materials

Polyesters. SCOTT BADER AND CO. LTD., Wollaston, Wellingborough, Northants. Fifth edition of this company's polyester handbook. Many illustrations of actual uses. 130 pp., ill.

Copper Roofing. RUBEROID CO. LTD., 1-19 New Oxford Street, London WC1. New roofing material is made from 42 gauge copper sheet with spherical indentations and a backing of filled bitumen. It comes in rolls. Fixing instructions. 6 pp., ill.

Rusty Steel Primer. A. SANDERSON AND CO. LTD., Ropery Street, Hull. Data sheet on Kingston Kurust primer. Information on coatings which can be used over primer. 8 pp., ill.

Aluminium Companies and Products. ALUMINIUM DEVELOPMENT ASSOCIATION, 33 Grosvenor Street, London W1. Directory of members with index of products written primarily for the potential user of aluminium products. 66 pp., unill.

Containers. KABI (ELECTRICAL AND PLASTICS) LTD., Cranborne Road, Potters Bar, Middlesex. Supplement to catalogue includes several plastic items. 3 pp., ill.

Acoustic Tiles. BRITISH PLASTER BOARD (MANUFACTURING) LTD., 15-17 Marylebone Road, London NW1. Slotted tiles for linings of buildings. 2 pp., ill.

Welded Steel. OLD PARK ENGINEERING LTD., Holly Hall, Dudley, Worcestershire. Shows what the company can undertake in welded steel fabrication. Illustrations of several large undertakings. 15 pp., ill.

Roadway Guard Rail. METAL SECTIONS LTD., Oldbury, Birmingham. Suggested uses of new design of guard rail section. Brief data. 8 pp., ill.

Cathodic Protection. STURTEVANT ENGINEERING CO. LTD., Southern House, Cannon Street, London EC4. Zinc anodes called Sturtepak are designed to give a steady protective current for 20 years to buried pipes. 2 pp., ill.

Marketing

Construction Equipment Exports to Argentina

DURING recent weeks a new export market with great potential has been opened up in Argentina for British manufacturers of construction equipment. A deal worth £1,435,000 has just been negotiated for the Province of Santiago del Estero through KNOWLES AND FOSTER, the London merchant bankers, and MERCATOR SA of Buenos Aires. In all, the value of business transacted by this one agency during the last eight weeks amounts to over £2 million and it seems there is a strong likelihood of more to come in the future. The managing director of Mercator, Mr. Jorge Stern who is at present in England, is most enthusiastic about the part played by British manufacturers in this stage of Argentina's development which includes the provision of a new highway system to replace their now somewhat outdated means of land communication.

During recent years there has been a marked tendency for British firms to branch out into the manufacture of much larger plant, the type of which was hitherto left almost exclusively to the USA to produce. Such a trend is inevitable with the greatly increased scale of the road programme but the high production costs of this equipment necessitate a proportionate increase in the size of the market and the establishment of extensive export outlets becomes vital. This upsurge of trade with South America is indeed a healthy sign and the present figures represent a substantial proportion of the plant exports to all parts of the world.

Firms recently involved include CONSTRUCTION MACHINERY LIMITED who have just sold a quarter million pounds worth of their Wakefield motor graders to the Province of Entre Rios and expect to sell more in Mr. Stern's latest deal, which also includes CHASESIDE loading shove's, CURTISS WRIGHT scrapers and FORAKY drilling equipment.

AEI To Supply Switchgear For New Stations

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED have received orders worth £1,200,000 to supply electrical switchgear to the Central Electricity Generating Board for the two new switching stations being erected at Lovedean, near Portsmouth, Hampshire, and at Gloucester.

Lovedean comprises the bulk of the equipment to be supplied by AEI and the value of the contract here is £800,000 covering the supply of 19 air-blast circuit-breakers, three rated at 275 kV 15,000 MVA, incorporating high speed auto-reclosing features, and sixteen rated at 132 kV 3,500 MVA comprising four transformer breakers, two bus-couplers, one bus-section and nine feeders. The order also includes outdoor isolators and all the associated equipment.

When completed, the station will be a transforming point on a supergrid line from the 550 MW Dungeness Nuclear power station which is scheduled to commence operation in 1965.

The equipment to be supplied to the Gloucester station is of a similar nature, there being three of the 275 kV air-blast circuit-breakers and two of the 132 kV type which will be used in a connection with the existing 132 kV substation at Port Ham. The site will eventually become a four-switch box-mesh station and its isolators and control equipment will also be supplied by AEI.

Shuttle Cars to Increase Steel Production

The UNITED STEEL COMPANIES LIMITED have placed an order with QUALTER HALL and COMPANY LIMITED, of Barnsley, for nine electrically driven shuttle cars for use in the ironstone mines at Dragonby and Stanton near Scunthorpe, with a further contract to follow shortly.

The cars will be electrically driven and capable of 4 mph when loaded to a maximum capacity of 15 tons. A new type of battery of 854 ampere-hours capacity, manufactured by CHLORIDE BATTERIES LIMITED, will give increased life between chargings and the design incorporates servo-assisted disc brakes and power steering to reduce driver fatigue.

Construction of these cars is a new departure for Qualter Hall whose activities have been concentrated on coal mining and pneumatic control equipment. The market, which is an expanding one, has been largely dominated by American manufacturers and Qualter Hall are believed to be the first British concern to provide any competition.

An Aid to Export Procedure

In response to inquiries from numerous firms who have experienced difficulties over matters of exporting goods, the INSTITUTE OF DIRECTORS, 10 Belgrave Square, London SW1, has recently introduced Britain's first-ever "Export Assistance Register."

The register contains the names of some 600 companies, engaged on the manufacture of more than 500 main categories of goods, who have offered to share the benefits of their export experience with members whose firms are not directly competitive. Listed is the address of each concern together with the name of the individual most qualified to render assistance. A code system is used to show the location of each and give an indication of the main product. If a firm has had special experience of exporting to any particular part of the world, details of this are given in parentheses after the address.

Any member who is uncertain about the best method of exporting a commodity to any part of the world has only to refer to the register and select the firm best qualified to render assistance in that particular field. The name of the inquiring firm will remain confidential and there will be no charge for the service.

At present the scheme is restricted to members of the Institute, but Mr. C. O. Stanley, Chairman of the "Export Action Now" committee, speaking of the value of the register to the potential exporter suggested that the assessment of results and further offers of assistance would help decide whether the scheme could be extended for future editions to the extent of distribution outside the Institute's membership to industry as a whole. So far, 500 copies of the first edition have been distributed to firms who have made a direct approach to the Institute asking for export assistance recently, but copies are available to interested trade journals on request.

Building Against the Clock

An exercise in work programming and cooperation between client, architect and contractor is to be demonstrated by HOLLAND & HANNEN AND CUBITTS (Great Britain) LIMITED who have received from BRITISH EUROPEAN AIRWAYS a £400,000 contract to build a stationery and printing store incorporating an office block in a matter of only 57 weeks.

Situated on a corner site at Long Drive and Victoria Road, South Ruislip, Middlesex, the new building is to have three storeys and measure 212 ft by 200 ft with a reinforced concrete frame clad in brick with precast concrete infill panels, and a flat asphalt covered concrete roof. Its function will be the replacement of existing stores occupied by BEA at London Airport.

Cubitts are already engaged on work for BEA in the area, this being the extension to Bealine House, Ruislip, the contract for which is valued at £280,000.

Another Weather Ship Contract for Marconi

Having successfully completed the supply and installation of equipment on two weather ships for the Air Ministry, the MARCONI COMPANY has been awarded a contract to equip a third ship which, like the other two, was previously a naval frigate; in this case, HMS Rushen Castle. On commissioning, the name will be changed to conform with weather ship nomenclature. The conversion will necessite an extensive refit and this will be carried out at the yard of the BLYTH DRY DOCKS AND SHIPBUILDING COMPANY, Blyth, Northumberland.

Automatic Booking System for BEA

BRITISH EUROPEAN AIRWAYS have placed a £2,500,000 contract with STANDARD TELEPHONES AND CABLES LIMITED for a new push-button reservation system. The present order comprises the first part of the equipment which is expected to be operational by late in 1963. The second part, bringing the total value up to £4,500,000 will follow a year later. It is claimed that when completed, the system will be the biggest in Europe and the most fully-automated system employed by any airline in the world.

Summing up the task of the new equipment, Mr. Anthony H. Milward, Chief Executive of BEA, said: "It will do away with all the drudgery and labour of filing and sorting record cards and allow us to get on with our real job of giving personal service to the customer."

At present carrying four million passengers a year, BEA expect to carry about 6½ million by the end of 1964 and it is hoped that by making reservations electronically, the additional traffic will be handled without a substantial increase in staff.

When fully operational, the new system will deal with some 3,000 telephone callers, 280 counter-callers and 500 telegraph messages per hour storing the particulars of each on magnetic drums and special, rapid-access magnetic tape files fed by four electronic computers which comprise the heart of the system. Bookings will be handled up to nine months ahead and during peak months half a million reservation record cards, 100,000 flight control sheets and over one million booking entries, at present made by hand, will be dispensed with.

The system will be installed in BEA's new permanent West London Air Terminal, now under construction, and initially only the London area will be served directly by the computers although provincial bookings may be telegraphed through and processed accordingly. Later it is planned that leased land lines will provide a direct connection with the principal BEA offices in the UK and on the Continent.

New Concrete Plant to Be Built

READY MIXED CONCRETE LIMITED have obtained planning permission for the erection of a central batching plant on a site half a mile north of Kings Cross Station London.

The design drawings are nearing completion and the new plant is expected to be operative at the beginning of 1962.

There has been an extraordinary increase in the use of premixed concrete over recent years on both the small site and the confined site. Some of the biggest contracts, such as multi-storey buildings in the centre of cities, are confined sites and the use of premixed concrete saves installing mixers and storage bins.

The Popularity of Decca Radar

DECCA RADAR LIMITED have transferred their radar training school from the old site at Blackfriars to a new establishment at Lambeth Pier where two-day courses will be run to provide Masters and Officers with operational training in the type of radar fitted to their ships. The school has three independent installations to provide training on 16 in, 12 in, and 9 in displays with both true and relative motion. So far the number of men trained since the courses started in 1950 amounts to 4,300.

It would appear that the Decca policy of backing up the sale of an installation with the provision of training facilities for the men who will operate it is a sound one, as orders for commercial marine radar sets now exceeds 11,000. This is a most impressive figure when it is borne in mind that the number of sets fitted to ships of the world's merchant fleet is estimated as being only 22,000. Sets have been supplied to every maritime nation in the world and in addition, the navies of some 41 countries have also been equipped with the more complex and specialized sets essential for modern warfare. The Royal Navy relies to a large extent on Decca radar and recently large repeat orders have been received.

The BR "Commonwealth" Passenger Stock Bogie

The Commonwealth bogie is one of a number of acceptable solutions to problems of bad riding of railway carriages. It gives a consistently smooth performance over very long periods.

THE Commonwealth bogie is an association of two seemingly unrelated ideas. Its proprietary design is aimed at giving railway stock a consistently smoother ride on average track, in combination with the use of steel castings for the main structural components.

English Steel Castings Corporation Limited are a subsidiary company of English Steel Corporation Limited of Sheffield and are steel casting specialists. They have supplied several thousands of bogies to Commonwealth designs, tailored to suit the application.

Directly or indirectly the majority made by the ESCC have been sold to British Railways. The most numerous version is the four wheeled passenger stock bogie which is appearing on all new main line coaching stock at present being delivered to BR.

The introduction of the Commonwealth bogie into this country from America was due to the foresight of Dr. C. J. Dadswell, managing director of English Steel Castings Corporation. In the course of a visit to America in 1937 for the purpose of studying the production of cast freight car bogies, he was struck by the size and intricacy of the steel castings being quantity produced successfully for other kinds of railway rolling stock by the General Steel Castings Corporation (now General Steel Industries Inc.). At that time not only bogie frames but also steam locomotive mainframes were being produced in cast steel, and Dr. Dadswell was fired by the ambition to start producing similar castings over here.

It may be asked, why was this country not already using steel castings for such purposse. The answer lies partly in the differences in American railroading practice, and partly due to the active salesmanship of the American steelfounders. Rolling stock, particularly steam locomotives, was generally larger and heavier than in Britain, and fatigue cracking of built-up steel frames and bogies had become a constant headache to the railroad engineers. They saw a direct monetary advantage in using the castings the steelfounders were offering, by saving on maintenance, despite the relatively higher first cost. In Britain, the weight of the locomotive frames was too great for the permissible axle loading.

Under these conditions the Commonwealth bogie grew and flourished. The General Steel Castings Corporation were not content with merely producing castings to customers' designs, but were prepared to design their own components and market them overseas by an associate called the Commonwealth Sales Corporation.

The Commonwealth bogie gives a smooth ride because the need for improvement in this direction was recognized and it is specifically designed to do so. It is also designed to utilize steel castings but it does not give its good ride on this account; though the inherently favourable properties of steel castings do offer benefits in other directions, particularly in reducing maintenance costs by obviating the need for inspection for signs of fatigue.

In 1948 Dr. Dadswell finally visited America to negotiate a licence agreement for his company to start producing the Commonwealth bogie under General Steel's patents. The moment was the most opportune for English Steel Castings to take on such an assignment, as they were in possession of a quantity of large machine tools formerly used for armament production.

English Steel's first sales were overseas on electric multi-unit coaches for New Zealand. The first locomotive units they supplied were four and six wheeled bogies for Metropolitan Vickers (later AEI), to be fitted on diesel electric locomotives for CIE in Ireland. Direct sales to British Railways started in 1955 when they supplied ten prototypes to the Eastern Region for fitting to five BR standard passenger carriages. Exhaustive riding tests soon showed that the Commonwealth bogie when new gave the carriage only a slightly smoother ride than a BR standard bogie in the same condition; but the most remarkable feature was the consistency of the good riding quality of the Commonwealth as the mileage increased. BR standard bogies showed a steady falling off in riding characteristics after about 30,000 miles, until stoppage for wheel turning became necessary at about the 65,000 mile mark. The Commonwealth, it was found, could be run for 150,000 to 180,000 miles before wheel turning, at the end of which the fall off in riding quality was still scarcely noticeable.

The first problem facing a railway operator trying to improve the riding comfort for his passengers is to isolate the responsibility for undesirable movement. Is it the track or the vehicle that is at fault? Generally the responsibilities lie in two different departments. Furthermore in Britain since the war there have been ample signs that the public are becoming more and more ride conscious. This situation is due partly to the ageing of track and rolling stock under wartime conditions of low maintenance and partly to the rapid growth of serious road competition which makes the traveller more particular. Where journey times are about equal, the chief incentive to the business executive to travel by train and leave his car at home is the higher standard of comfort he may reasonably expect on the journey; comfort that includes riding quality as a pre-eminent ingredient, since he will probably want to read and write on the train. Bad riding is therefore bad for business.

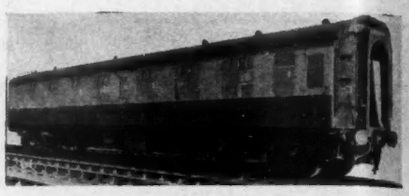


Fig. 1 BR coach fitted with Commonwealth bogies.

The first step was to obtain instruments to isolate the causes of bad riding. In this way the long standing feud between the civil and mechanical engineering departments was abruptly ended. Where the track was sub-standard due to wartime arrears of maintenance, it was put right. But bad riding remained and now it was the mechanical engineer's turn.

SHORT TERM SOLUTION

The immediate short-term solution was to design a bogie for new BR standard stock incorporating the best features of the designs of the four main line companies. But it cannot be said that any direct improvements in riding resulted, though the standard bogie was reasonably light on maintenance. Nearly 20 proprietary designs with a successful history in other countries were then investigated, five of which received active consideration. Then the Commonwealth bogie appeared, production having been started by English Steel Castings Corporation at Sheffield.

The British Transport Commission's attention was at once drawn to it not only on account of its consistently excellent riding qualities, but also, equally important, the low maintenance costs due to the long mileage between overhauls. Exhaustive trials with the five prototype pairs already mentioned fully confirmed these claims and led to the steady flow of orders for passenger stock bogies that ESCC have enjoyed ever since.

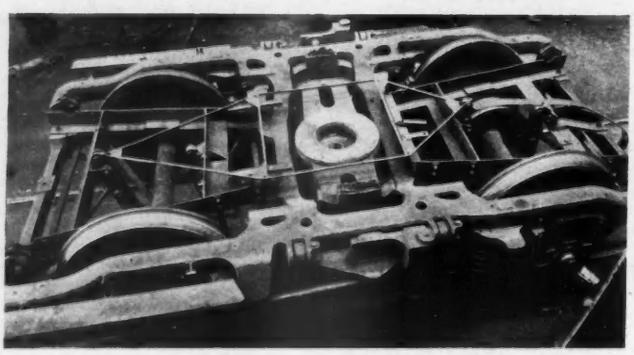


Fig. 2 (left) Assembled bogie ready for fitting to BR carriage.

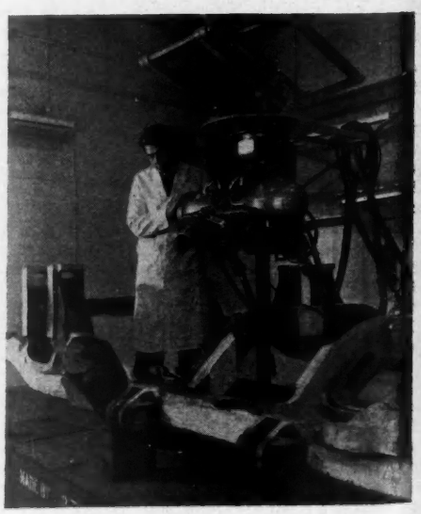


Fig. 3 (right) Bogie castings are checked for dimensional accuracy and for soundness. A complete X-ray check is made on 10 per cent.

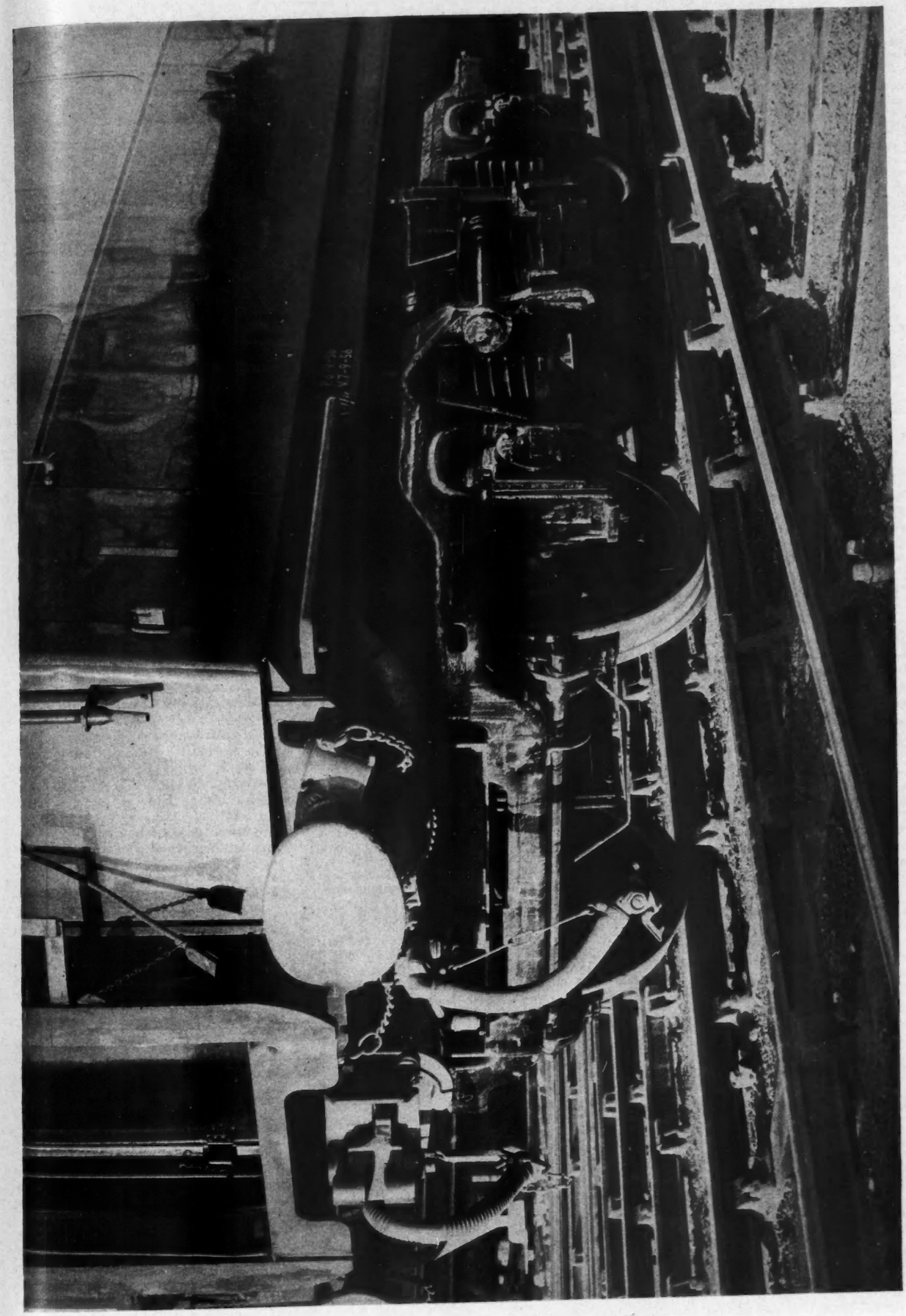


Fig. 4 A forceful product of American design, successful in Britain because of the traveller's growing insistence on a comfortable ride.

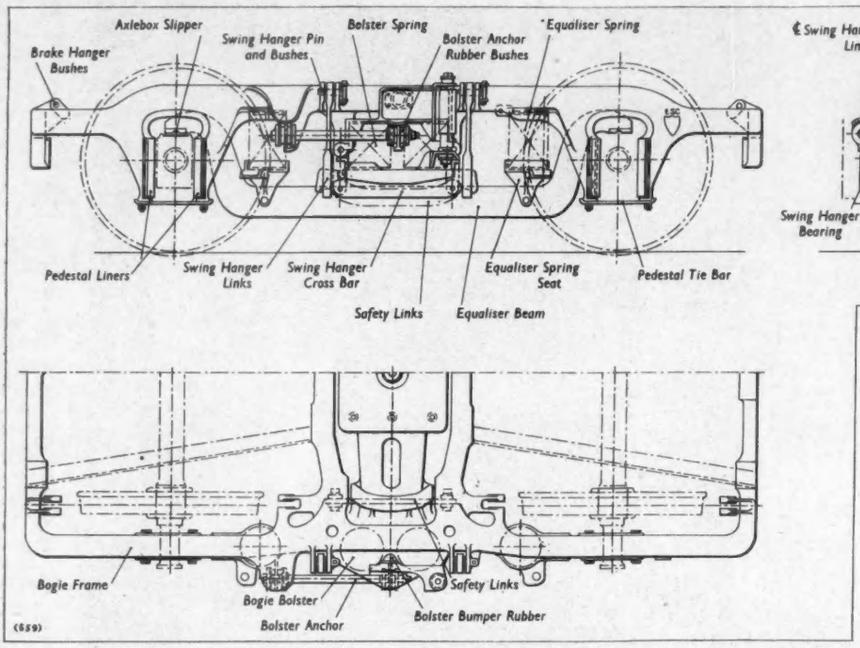


Fig. 5 Drawing showing principal components.

Production is currently running at 40 bogies per week. The BTC have also purchased quantities of motorized and trailing Commonwealth bogies for multiple unit stock, the Eastern Region Clacton and Walton overhead electrification scheme, and trailing bogies for the Southern Region Phase II Kent Coast electrification multiple unit stock.

However, though the Commonwealth is giving the lengthy breathing space needed, so far as BR are concerned the writing is on the wall. BR have been busy evolving a fabricated design of their own with the many advantages of the Commonwealth but without its penalties of cost and weight: limitations both stemming partly from the use of steel castings but also because the Commonwealth is an equalized bogie.

STEEL CASTINGS

The good riding quality of the Commonwealth accruing from the general design features of the frame and suspension system are undisputed; but a certain controversy exists over the need to use steel castings. The Commonwealth Steel Corporation started making cast steel bogies as long ago as 1904 and cast steel is almost universally applied to bogies in the USA today. British Railways' new fabricated design is reported to give as good a ride as the Commonwealth bogies at about two-fifths of the cost of production.

To what extent the disparity in viewpoint is dependent upon technical rather than human considerations is hard to say. It is known that the success of a bogie in railway service depends on several factors outside its own design, such as the length and weight of the vehicles, the track, the type of buffers and couplings in use, and average speeds.

One of the strongest points in the favour of the Commonwealth is the non-fatiguing characteristic of cast steel. On the other hand, although the designer can provide exceptional strength with minimum weight by using castings, there is a practical minimum metal thickness, generally ½ in, below which he cannot go. On a size-for-size basis, therefore, the Commonwealth will tend to be heavy compared with a fabricated counterpart for small bogies, but light for the larger units.

The BR passenger stock bogie is probably on the wrong side of the "break even" point, depending on how much less rigid one is prepared to accept a fabricated frame. (The weight of the Commonwealth bogie for BR passenger stock is also influenced by the use of forged equalizer beams which have to be fairly substantial for the load distribution, which are characteristic of the good ride.)

But the weight consideration does not detract from the advantage of the non-fatiguing characteristic. Commonwealth designers distribute the metal in a homogeneous structure, changing thickness as required to suit the applied loads without abrupt changes or sharp effects. Thus uniform stresses are maintained throughout; the stress concentrations liable to be found in a fabricated bogie design are eliminated. On a strength-for-strength basis the Commonwealth can be made light by virtue of freedom from joints: use of a casting ensures that the bogie frame is kept square at all times.

On the other side of the picture is BR operating experience with fabricated bogies extending over many years. The relatively high cost of Commonwealth would certainly be considered justified if fatigue failure of bogie frames had ever become a major problem, as in the USA; but BR informed ENGINEERING that failures of fabricated bogies in this country are practically unknown and certainly do not constitute a major problem.

DESIGN FEATURES

The principal design features are shown in Fig. 5. The chief technical features contributing to its good riding factor are enumerated below:

(1) The use of equalizer beams between the bogie frames and axlebox instead of direct springing to quickly distribute the loads throughout the bogie, particularly when passing over rail joints. The instantaneous journal bearing loads are thus reduced and weight transfer (and hence wheel slip) minimized.

(2) The long inclined swing links for secondary suspension, set at a slight angle to the vertical to resist lateral forces.

(3) The central bearing offers a large-area horizontal surface which eliminates the need for side bearers. Special friction materials resist "shimmying"—the tendency towards lateral hunting as the wheel flanges become worn.

(4) The secondary spring plank is made as wide as possible to limit the degree of roll.

(5) The bolster anchor transmits the traction and braking forces to the bogie frame and eliminates rubbing plates between the bogie frame and bolster. There is therefore no tendency towards bad riding during braking due to friction. (In the case of a motorized bogie it also transmits the driving traction forces.)

The aim of the Commonwealth bogie is to provide wherever possible a large static deflection of the primary and secondary springing. A large amount of movement will result in a low period of oscillation and minimum wheel flange wear. It is a simple matter with the Commonwealth design to limit the lateral movement, but the period of oscillation will be increased and riding quality and flange wear slightly sacrificed.

The Commonwealth design also leaves the space between the rail wheels clear for mounting electric or hydraulic traction transmission, when the transverse member is stiffened for anchoring the nose-suspended motors.

Underlying the Commonwealth design are many years of exhaustive testing under every conceivable kind of condition, both controllable and uncontrollable. Experimentation with railway rolling stock in service presents a number of difficulties; for instance, a wet rail can markedly affect bogie riding characteristics. Such difficulties, coupled with empirical nature of finalizing a new bogie design, mean that the Commonwealth bogie will appear on BR in far greater numbers than at present before there is any likelihood of being superseded, even assuming that the tests being conducted with the Swindon bogie produce the hoped-for results.

Fig. 6 Motor bogie frame for 1,250 hp electric locomotive type AIA-AIA.

Boron Silicide—New High Temperature Material

Development of boron silicide, a new high temperature material, has been announced by the Research Division of the Allis-Chalmers Manufacturing Company, Wisconsin, USA.

The elements boron and silicon form two well-characterized chemical compounds, hexaboron silicide (B_6Si) and tetraboron silicide (B_4Si). These two silicides—products of high temperature materials research—are available in quantity as black, microcrystalline, free-flowing powders of about 75 microns. Free silicon, the most objectionable impurity in boron silicide, is maintained at an extremely low level by means of an exclusive Allis-Chalmers purification process.

Boron silicide is a unique high-temperature material in the family of refractory borides and silicides. It is exceptionally resistant to oxidation as a result of the formation of a thin, protective coating of boron-silicon-oxygen composition which results upon exposure of the material to high temperatures in air. It is the only known high-boron content material that can be used at 1,400° C in air for extended periods.

Boron silicide powder lends itself to fabrication by conventional powder metallurgical and ceramic techniques; it can be hot pressed to give very dense bodies; it can be slip cast; and it can be oxide-bonded or self-bonded. Oxide-bonded boron silicide is formed when the compacted powder is sintered in air. Self-bonded boron silicide is formed by sintering the compacted body in an inert atmosphere.

Oxide-bonded boron silicide is machinable when pre-sintered at about 1,095° C in air. The outer, hard shell can be removed with diamond or carbide tools, after which conventional cutting tools can be employed to fabricate intricate shapes. After fabrication the finished shape is sintered in air at 1,370° C with only negligible shrinkage.

Boron silicide has excellent thermal shock resistance, partially due to its low thermal expansion coefficient. Oxide-bonded B_4Si and B_6Si plates ($2{\cdot}5 \times 2{\cdot}5 \times 0{\cdot}3$ cm) have been cycled from 1,095° C to 25° C, by means of alternate furnace heating and air blasting, without cracking. These plates can also be water-quenched from 1,095° C without shattering.

Tetraboron silicide disproportionates above about 1,200° C. Consequently, most preparations of B_4Si contain slight traces of B_6Si ($3\ B_4Si\ 2 \rightarrow B_6Si \times Si$). Some solid solution formation between silicon and hexaboron silicide results, and there is a negligible volume change associated with the disproportionation. For some applications, therefore, B_4Si may be superior to B_6Si because of the added oxidation resistance imparted by the silicon resulting from disproportionation. Most work has been concentrated on B_6Si.

Because of its high boron content, boron silicide is applicable in nuclear reactors as a neutron control device, for shielding structures, and as a burnable poison to absorb excess neutrons in some types of reactors. Its excellent oxidation and thermal shock resistance suggest uses in general refractory areas, particularly where other boron materials, such as boron carbide and boron nitride, cannot function at high temperatures in atmospheres containing oxygen.

Automatic X-Ray Crystallography

Research into the atomic structure of crystals will be significantly accelerated by a new X-ray diffraction technique which is almost entirely automatic. Developed at Bell Telephone Laboratories, New Jersey, USA, it involves the use of a high-speed, general purpose, digital computer to generate a control tape which automatically operates a special type X-ray diffractometer. Data readings from the crystallographic experiment are automatically recorded on a punched tape which is then fed back into the computer. The computer correlates the information, corrects for experimental factors, and prints out crystallographic data in a form convenient for analysis.

The new technique, called PEXRAD (Programmed Electronic X-Ray Automatic Diffractometer), was described in a paper by Dr. S. C. Abrahams, a Bell research engineer, at an American Crystallographic Association meeting in Boulder, Colorado, on 31 July. The equipment for the experiment is in a final stage of construction and should be in operation within a month.

Dr. Abrahams reported that with PEXRAD, it will be possible to obtain more than 17,000 readings a day; and while they are being taken automatically, a crystallographer will be left free to evaluate collected data. With manual methods, the most an experienced crystallographer can hope to obtain is about 3,000 readings a day, and then probably only for one or two days at a stretch since the measurements require his complete attention.

A new automatic method of X-ray crystallography using punched-tape, is expected to accelerate research into the structure of crystals.

In the study of crystals by X-ray diffraction, a beam of X-rays is shot into a crystal and is scattered by the atoms in the crystal. However, if the beam strikes a crystal plane at a certain angle, the small scattered beams from the atoms combine into a diffracted beam that comes out of the crystal in one direction. In one method, the diffracted beam is detected by a scintillation counter. Then the crystal is rotated slightly and the intensity of the diffracted beam is measured again. After about 50 readings, the crystal and the counter are moved to new angles and the beam that is diffracted by another crystal plane is measured. By this method of measuring the amount and direction of the diffracted beams, a crystallographer can obtain clues as to the positions of the atoms in the crystal.

The author explained the PEXRAD method in detail: information such as crystal lattice constants, the wavelength of the X-ray beam, and instrumental constants are fed to the computer on punched cards, along with a compiling programme. The computer generates a magnetic tape from which a punched paper tape is made. Fed into PEXRAD, it controls the motors which rotate the crystal and receiving counter into position, and then causes an X-ray beam of prescribed wavelength to irradiate the crystal for a precise length of time. The intensity of the beam which is diffracted by the crystal is measured and recorded on punched tape. The crystal is automatically rotated to the next position and the process is repeated.

The punched tape from PEXRAD containing the readings is converted to a magnetic tape and is fed back into the digital computer. The computer integrates the intensities, corrects for absorption, rotation, Lorentz and polarization factors, and prints out the corrected data from which the location of the individual atoms can be calculated.

Finding New Uses for Oils

It has been shown that, by spraying an emulsion film over seed beds on dryish soil, farmers can trap the available moisture and so encourage germination and growth. Plants apparently have no difficulty in penetrating a mulch as thick as one tenth of an inch. The technique can also be extended to orchards and plantations, to the reseeding of rough grazing and to reafforestation programmes to stem the advance of deserts.

The new technique was established by research workers in the Esso Group, both in Britain and America, and a brief report of it is given in the summer edition of the *Esso Magazine*. The laboratory at Abingdon, Berkshire, is now cooperating with the Linden research centre in the USA on field tests of various applications which are being carried out on five continents.

One of the latest projects now under way at the Linden Laboratory is the development of a tractor-drawn machine to plant seeds and spread the mulch in one operation. Thus, an unusual opportunity may soon arise to bring more land into cultivation and to expand the yields of existing farms in arid zones.

Another example of transatlantic cooperation within the Esso organization concerns the development of a new series of resins called Buton resins, which are prepared by polymerizing petroleum chemicals—butadiene and styrene. Already these versatile resins have found a wide variety of applications and many further outlets are currently being explored by Esso engineers.

As surface coatings, they make varnishes of very high quality and can be used in the preparation of coloured enamels of various types—being unusually resistant to chemicals, solvents and water. They are also attractive as linings for metal containers and steel pipes. In the form of primer coats for household appliances and motor cars, Buton adds remarkable durability and pleasing appearance to the finish.

In the field of plastics, Buton resins are used with commonly available reinforcements—such as glass-fibre, paper and asbestos—in the manufacture of radio and television components, high-strength glass-reinforced pipes and various other types of articles which demand higher-than-usual quality and performance.

Renewed Vigour in Machine Tool Research

Criticism has been levelled at Britain's machine tool industry in no uncertain manner. The Melman Report and the Mitchell Committee agree that research efforts are inadequate. However, the development programme of Alfred Herbert Limited, recently expanded by the opening of new laboratories, shows no lack of imagination or effort.

BACKED by mechanical, metallurgical, electrical, metrological and various other specialist sections, the new Alfred Herbert Applied Research Department's primary aim is to develop complete machines to give increased production wherever they are used. To this end, machines are developed in many general directions: reduction of operator responsibility, reduction of idle times, reduction of tool and machine setting times, and increase of initial and subsequent accuracy, being the main objectives.

Orthodox Machines

A large proportion of such machines incorporate electronic programme-control techniques, but although there is an increasing demand for such machines, the development of more orthodox types is continuing.

An example of the latter type is a new Preoptive copying lathe—the "No. 7 Preopticop." This is being developed to investigate the possibility of manufacturing a flexible machine for the production of small quantities of components, with special emphasis on quick setting. A longitudinal and a transverse profiling slide is fitted, the former having a quick-power traverse operated by hydraulically-actuated clutches. Facilities are provided for quickly changing templates and for the use of a large variety of toolholders. A patented saddle-clamping technique is also incorporated to ensure accurate positioning and, hence, repetitive accuracy of machined components.

The Preoptive design is still undergoing developments, consistent with advances made in the past. A "No. 3 ElectroPreoptive" capstan lathe is being tested with a thyratron-controlled variable-speed a c motor. This provides an infinitely-variable speed-selection range, instead of the more usual choice of speeds within a stepped range. The benefits of this development have not been confined to this machine, indeed experience gained has been applied to an infinitely variable feed drive now fitted as standard to two types of milling machine.

Electronic Control

Good progress has been made in the direction of automatic electronic programme control within the last few years, and machines are rapidly being released from the restrictions of mechanical controls, with their inherent setting problems, excessive idle times, and reliance upon the ever dwindling ranks of skilled operators. Nonetheless, despite the advances that have been made, electronic control is still a young technology and the possibilities of further development are almost boundless.

One line of development in this direction is the freeing of feed drives from mechanical coupling with the spindle motive power. This is done by using separately-controlled motors with feedback, so permitting infinitely-variable control of spindle/feed ratios. Rapid response of the feedback circuits is required when adopting this technique, in order to ensure close regulation of the relation between feeds and speeds. In one project, involving a capstan lathe, success is being met in this direction.

A prototype programme-controlled "No. 2 Auto" is also under development—having punched card control through the medium of a static card reader. This machine also has electronically-controlled screw feeds driven independently of the headstock. Special provision is being made to ensure accuracy of functioning under a wide range of feed rates and loads. Independent motors power the speed, feed, and quick-power traverse functions; the spindle, being chain-driven, is entirely isolated from heat-producing members, such as gears and clutches. Automatic clamping, of a type that provides rigidity and repetitive accuracy, is an additional feature of the machine.

Electrical control techniques are investigated and developed in the electrical laboratory before becoming part of the development programme for a complete system.

Another interesting facet of this development project is that an attempt has been made to isolate the clean and dirty areas of a coolant-using machine in order to enhance the long-wearing properties of the sliding members. A contribution to the realization of this objective has been the incorporation of independent drives.

Another programme-controlled capstan lathe is being used in connection with stopping spindles at predetermined positions. When fully developed, this procedure will facilitate such motions as the loading of components and the insertion of an external power-operated chuck wrench—a parallel development which is being conducted elsewhere in the firm's Applied Research Department. The latter unit will permit the automatic operation of the company's "Coventry Chuck," without restricting the spindle bore of the machine. The degree of grip, which is indicated on a torque gauge, can be varied through the medium of a magnetic clutch which has a variable field. An experimental set-up enables the torque provided by the wrench to be calibrated to the grip available at the chuck jaws.

The development of power and power-transmission units is also being pursued independently of the complete systems of which they will eventually form a part. For example, a test rig has been devised for testing the performance of small electric clutches with a view to determining the electromagnetic conditions relative to torque capacity. It also enables the rate of clutch-plate wear to be ascertained under predetermined cycles of operation.

Feedback Response

Unlike a human operator, an electromechanical control system experiences a certain degree of "follow up" in its operation, since it responds to a feedback signal after the occurence of the event which it is designed to control. Just the same, if the motions of the machine are consistent, the electrical circuitry can be designed to overcome and produce a "dead-beat" operation of the system. One of the factors militating against this is the "stick-slip" motion of the sliding members which introduces an unstable element; even if the slides are well designed and well lubricated, this will always occur at some point during the decelerating motion at the end of the slide travel.

To overcome this difficulty, a considerable amount of applied research is being conducted toward the development of air-lubricated and hydrostatic slides. Not only must the direct problems associated with the introduction of air be dealt with, but the many side effects on the rigidity of the sliding members, particularly under heavy unsymmetrical loadings, must also receive attention.

A test rig has been built on which all these and other related problems may be investigated prior to the construction of a full-scale drilling machine embodying a coordinate-positioning air-lubricated table requiring accuracy of response under heavy unsymmetrical loading.

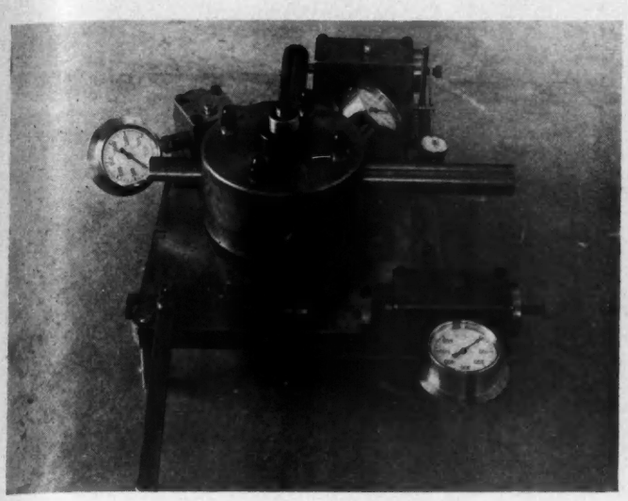
Air lubrication will also contribute to the life of sliding members by the exclusion of swarf due to the escaping air. Furthermore, the ease of movement of manually-operated machines will be enhanced. For these reasons, a surface grinder with an air-lubricated table is being developed.

Two other developments which are of a less revolutionary nature, but which will have a considerable effect on production efficiency are: (1) improvements in "microbore" tools which, by eliminating variations to the unequal clamping pressures applied by different operators, will ensure accurate resetting even by unskilled men; and (2) fluteless taps, operating on a similar principle to thread rolls, which will reduce the frequency of tap breakage during the tapping of small holes.

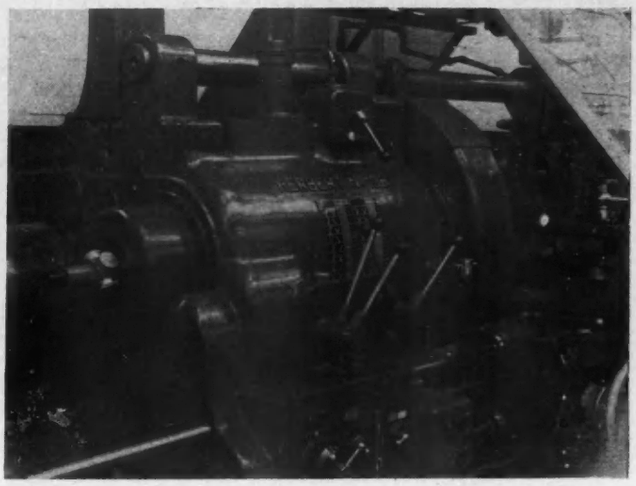
Temperature Problems

The principal enemies of machining accuracy are loss of machine rigidity and changes in machine alignments, due to variables such as temperature. In continuing their research efforts in this region, the department have constructed a large number of test rigs. One such rig consists of a skeleton headstock which has facilities for interchanging the main bearing bushes. Tests to ascertain increases in temperature and noise can be made on a wide range of spindle and bearing assemblies, without the complica-

Research Report
on work of the
Applied Research Department, Alfred Herbert Limited, Coventry.



A test rig is used to investigate various methods of clamping turrets. In the illustration, the model is being used to determine the efficiency of the "binder clamp" method.



Optical measuring techniques are used to ensure a high degree of accuracy in bed levelling operations. This keeps the travel path of the tool in close relationship with the spindle axis.

tions which arise from the adjacent gears, shafts and clutches of a complete headstock. This illustrates the care during applied research whereby each feature is investigated independently so that results are not affected by extraneous factors.

Although spindle bearings are preloaded during assembly, temperature changes due to working conditions can affect the degree of preload. Accordingly, tests are conducted on bearing assemblies which are designed so that the effects of temperature changes are nullified. Investigations into the heating effects of oil-churning and into the degree of cooling provided by an efficient lubrication system are also made.

The effects of temperature rise on the headstock casing itself is being investigated by the use of a specially-built headstock. By providing headstock mounting brackets in the same plane as the spindle axis, the spindle height is unaffected by increases in temperature, and suitable insulation minimises the amount of heat radiated and conducted to the bedways.

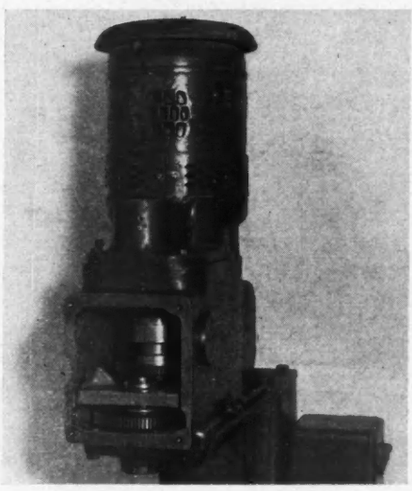
Machine-bed Rigidity

The rigidity of the machine beds is also of paramount importance; not only is it necessary to design the bed so that it will withstand heavy torque loads and bending loads (such as during the traverse of a heavy turret) without distortion, but methods must be devised for levelling beds so that all support points on the foundation carry their designed share of the loads. Tests are carried out on many designs of beds constructed to support adequately the static and moving loads and, at the same time, to provide ample clearance for the disposal of swarf between the bedways. Each design is statically loaded at each load-bearing point in turn, and the deflection of the various members is accurately measured.

It is believed that the optimum design for present-day needs has been achieved by these methods, but tests will proceed, to ensure that the introduction of future developments, imposing new or additional loads, will not be postponed because of the lack of an adequately designed bed.

It follows that a well-designed bed must be carefully levelled during the erection on its foundations in the machine shop. In the firm's laboratory, bed level is determined with highly sensitive optical instruments and, from the results obtained, instructions can be formulated for the routine levelling of beds on site by erection fitters who would not normally have access to such instruments. By this means, the designed relationship between the tool path and the spindle axis is maintained to a high degree of accuracy.

Attention is also given to the effects of wear and corrosion, so that the qualities of the machine tools can be maintained throughout their working lives. Mention has already been made of tests to determine clutch life, of developments with air-lubricated slides, and other work to prove the wearing properties of new designs of machine tool components. Additional test rigs have been built to enable gear materials and gear hardness treatments to be compared under conditions that reproduce many years of overloaded working within the space of a few days, so that no great delays are incurred before an improved material or heat-treatment method



A test rig has been devised to provide a rapid method of comparing results of various gears materials subjected to heavy loads.

can be introduced into the gear production line. New lubricants and methods of lubrication are similarly tested.

Packaging

To ensure that a machine is received by a customer in any part of the world in the same condition as it leaves the works, a packing case has been developed and tested under actual and simulated climatic conditions. The early part of the work on this packing case was reported to the Production Engineering Research Association and now forms a part of their recommendations to industry in *Packaging of Engineering Equipment*, which was first published in 1949.

The advantages of electrical control systems are now well established in the machine tool industry and have received full attention at the Alfred Herbert Applied Research Laboratory. Tests of electrical systems are conducted under the supervision of electrical research engineers and, before a complete machine programming or control system becomes a reality, extensive development work is carried out in the firm's electrical laboratory.

Among units undergoing test is an example of static switching—a Herbert development which applies known physical principles to machine tools. Since, on many machine tools, the logic in a sequential system is supplied by the machine itself in the form of feedback signals from limit switches, pressure switches and other devices actuated by the machine's elements, this static switching system must be primarily concerned with sizeable output units. Where necessary, low-power devices are provided to supply interlocks and memory functions.

Life tests are made on contactors and relays using a transistorised counter to automatically record the number of operations.

The Herbert "Datatrol" unit for the automatic positioning of the table and spindle head of the Herbert/DeVlieg jigmil, a development of the electrical laboratory, is already well known and used. Plans are in hand for extending the versatility of this technique of control by the introduction of an automatic bar-cycling system, the prototype of which is now under tests.

The accuracy of automatic positioning systems depends upon the accuracy of proximity devices. Several such devices are being developed, the aim of their design being robustness, reliability, repetitive accuracy and the ability to replace limit switches wherever possible. This supports the work of the drilling machine table already mentioned.

Electrical components used in machine loading and transfer systems are devised and subjected to exhaustive tests. A small-scale model of a d c linear motor having many such applications has been developed. Another development has been a multi-station shuttle-type conveyor which, despite the absence of physical contact with the components transferred, "remembers" the component positions. Correct sequencing is accomplished with a special counting system.

Although this report indicates only a part of the work being carried out by the Applied Research Department, it gives an indication of the steps being taken to ensure that machine tool products provide the accuracy and speed of production required by industry, and that future requirements will be well met.

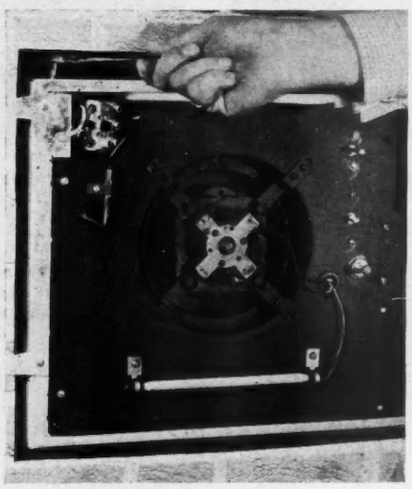
Convector Central Heating

With the steady increase in costs, it is the aim of all builders to save construction wherever possible. One of the items that modern equipment allows to be eliminated is the chimney stack and, as each one may cost from £75 to £100 or more, the omission can represent a considerable saving. Recently introduced to the market, the Axiatherm convector heater is one of the devices that enables this to be done.

The present Axiatherm unit is designed to be built into the wall of a room, preferably under the window. A free-standing version is to be introduced later. The dimensions have been chosen to suit an integral number of bricks to make installation easy, and there are setting screws on the case to centralize the unit in the space. The process can be seen in the first illustration. Actual case dimensions are 35 in by 15 in. The front panel is extended all round to overlap the edges of the inset cavity and so gives a smooth finish to the installation.

Air from the room is drawn into the heater through the grille on the left, which gives direct access to the fan. Below the grille is a slot, behind which there is a thermostat that can be set to the required room temperature. This thermostat can also be seen in the upper illustration. The fan (and indeed the whole unit) is designed for quiet operation and the motor runs at less than 1,000 rpm, a speed that also gives extended life to the bearings. The fan blades are the backward inclined type, also making for silence in running, and rubber blocks are used for the motor mounting to eliminate the transmission of vibrations to the frame. The motor is of shaded-pole design with continuous rings.

From the fan, the air passes through a volute to give true flow to a pressure chamber and then is distributed over the heating elements. These are nickel-chrome wire operating at black heat and have ceramic anti-vibration mountings. The maximum rating is 3 kW.



(Above) Installation is simple; adjusting screws centralize the unit in the space.

(Left) The Sterling Axiatherm convector heater is designed to form part of a packaged central heating system made up of several centrally time controlled units.

After passing over the banks of elements the heated air is distributed to the room through the three sets of grilles on the right. Fixed in the air stream is a temperature cutout set to operate in case of overheating caused, for example, by the accidental coverage of the outlet grilles as when an armchair or other article of furniture is inadvertantly placed in front of the heater and obstructs the free flow of air.

Between the sets of grilles are the panel controls. These consist of the thermostat setting knob and the control for full or half heat, full or half fan speed, and fan alone, to circulate air during hot weather. There is also an indicator light to show when the unit is functioning. The interior can be reached by removing the front panel and an interlocking switch automatically cuts off the supply if this is done. The facings behind the front panel are painted black to prevent unwanted reflections coming through the grilles.

The makers of the unit, Sterling Engineering Company Limited, Dagenham, Essex, a member of the Land and General Developments Group, envisage a complete central heating system built up from these units in conjunction with a time controller that has been produced for the purpose. This is a centralized unit including a synchronous clock and relays which are capable of handling several heaters. The clock drives three sets of contact arms so that the units can be switched on and off to give three separate heating periods. Fuses and a main switch are also fitted in the panel. To prevent freezing up during unusually cold weather, a thermostat can be installed in any particularly cold spot to override the time clock and switch on the heaters. Several such thermostats can be installed if desired. The system will switch itself off again immediately the temperature around the thermostat rises above freezing. Typical heating periods for which the clock can set are from 7 am to 9.30 am, 11.30 am to 1.30 pm; and from 4 pm to 10 pm.

In addition to controlling the heaters, the central clock can be wired in to control an immersion heater so that hot water will become available when the heaters come into action. Lighting circuits can also be connected in.

Low initial cost is one of the claims for the Axiatherm central heating system. Three heaters and a control panel, providing an output of some 33,000 Btu per hour, can be purchased for approximately £100 (including purchase tax). A five heater system would cost about £160 and the control unit alone about £25. These figures do not include installation costs which would of course, vary according to local conditions. Other claims are that heating is immediate (and so is switch-off), that the system is frost proof, and that there are no pipes or ducting.

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